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Under the Radar

Ocean Acidification Often Overlooked but Threat Is Real

By Emily Bird, NEIWPCC

Ask just about anyone to list the world's most pressing water-related problems, and ocean acidification, if it even makes the list, probably won't rank high. That's not good. The fact that our oceans are growing increasingly acidic is a serious environmental problem that could have alarming consequences for areas such as New England, where fishing plays a vital economic role. It's also a problem with deep and global roots.

Before the nineteenth century, about one-third of atmospheric carbon dioxide was readily absorbed and neutralized by the ocean. But that all changed with the onset of the Industrial Revolution and the introduction of large-scale anthropogenic (human-caused) carbon emissions. Since the 1880s, atmospheric carbon dioxide levels have increased at an unprecedented rate, overwhelming the oceans' carbon-neutralizing capabilities and triggering the acid-producing chemical reaction called ocean acidification.

Despite this connection to the politically sensitive issue of climate change, it's time this issue got the attention it deserves. While there is much yet to learn about ocean acidification, what we know already has raised plenty of concern in the scientific community—and spurred an initial effort by EPA to deal with the problem. EPA's effort is to be commended, but we at NEIWPCC are less than enthused with the approach. More on that later. First, a little background.

Increased carbon in oceans means increased acidity, and shellfish are feeling the effects. They have a harder time building shells in an environment made corrosive by ocean acidification, and that's raising environmental concerns—as well as economic worries about coastal communities dependent on shellfish production.

The Science

An ocean acts as a carbon sink, meaning it absorbs carbon dioxide in the atmosphere. Excess carbon dioxide in the air results in an excess in the water, which spurs a chemical reaction that produces hydrogen ions. Those ions increase ocean acidity and, in the process, reduce carbonate in the water—the very substance that shelled organisms (a.k.a. calcifiers) need to form calcium carbonate, the key building block for shells. That's especially harmful because the impact isn't limited to shelled sea life such as coral, mollusks, and crustaceans. Ocean acidification also sets in motion the ecological phenomenon called trophic cascade, in which an increase or decrease in the population of a species can have a profound effect on other species that share the same food web.

In an interview with Mark Green, professor of marine science at Saint Joseph's College in Standish, Maine, he said a chain reaction of impact under trophic cascade, whatever the cause, is difficult to predict and can only be speculated based on community level interaction—the intricate predatory linkage among species in a food web. But there's no mystery around what happens when species at higher levels in a food chain experience a decline in their prey.

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Trade Talk

The Prospects for Nonpoint-to-Point Source Water Quality Trading—and NEIWPCC's Potential Role

By Per Onsager, NEIWPCC/
University of Massachusetts Lowell

For the greater part of human history, civilizations have embraced the concept of trading goods and services. The idea behind a marketplace is simple: We'll exchange just about anything for something of perceived equal or greater value. But to prosper, a market requires a tremendous amount of care, rules, and good old-fashioned teamwork. Done right, a market can create economic prosperity for buyers and sellers and even contribute to the well-being of a community. The trading of water quality credits is an example of a market that delivers more than financial benefits. Sellers create credits that buyers have an economic incentive to purchase—and the result, if all goes according to plan, is less water pollution at a lower cost.

Water quality trading between point sources of pollution such as wastewater treatment plants is fairly well established—and has been going on successfully in many places for some time. Things get more complicated when you start talking about trading between point sources and nonpoint sources such as farms. But those complications aren't dampening the interest. Lately there's been much talk and action around point-to-nonpoint trading as well as growing interest in the possibility of designing and implementing point-to-nonpoint markets in the Northeast. And the closer you look, the more it becomes apparent that NEIWPCC may have a pivotal role to play.

Basic Trading

To understand water quality trading, it's important to first understand the basics of the Clean Water Act's water quality process. Under the CWA, states must assess their waters every two years and create a list of water bodies that are impaired—that is, which don't meet the water quality standards for their designated uses. (If one of a water body's designated uses is to provide drinking water, for example, it will have to meet higher standards than one that is not a source of drinking water.) For all impaired waters, the states must write a Total Maximum Daily Load or TMDL, which specifies the maximum amount of a pollutant a water body

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Inside

NEIWPCC
New England Interstate Water Pollution Control Commission

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Ronald Poltak

Deputy Director
Susan Sullivan

Established by an Act of Congress in 1947, the New England Interstate Water Pollution Control Commission is a not-for-profit interstate agency that employs a variety of strategies to meet the water-related needs of our member states—Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. NEIWPCC coordinates forums and events that encourage cooperation among the states, develops resources that foster progress on water and wastewater issues, represents the region in matters of federal policy, trains environmental professionals, initiates and oversees scientific research, educates the public, and provides overall leadership in water management and protection.

NEIWPCC is overseen by 35 Commissioners—five from each member state—who are appointed by their state governors. Each state's delegation includes the commissioners of its environmental and health agencies (or their designated representatives), with the rest of the delegation consisting of individuals appointed to the Commission by virtue of their experience and interest in water and wastewater issues. An up-to-date list of NEIWPCC's Commissioners is available at www.neiwpcc.org/commissioners.asp; please note that the number of NEIWPCC Commissioners from each state can vary from year to year due to the gubernatorial appointment process. NEIWPCC's staff, under the direction of Executive Director Ronald Poltak and Deputy Director Susan Sullivan, develops and carries out programs endorsed by our Commissioners.

IWR
Interstate Water Report

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Questions or comments about *IWR* articles are welcome and appreciated. We also encourage article submissions. Please send material to shochbrunn@neiwpcc.org.

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From the Executive Director

Sea of Reasons for Increased Ocean Protections

I love the ocean, you love the ocean. Our oceans cover roughly 70 percent of the earth's surface. They provide humanity with so many of the essentials necessary for sustaining a full life. We need to take better care of them.

The challenges facing our oceans affect each and every one of us. Pollution has created immense islands of trash as well as dead zones that plague large segments of this treasured resource. Climate change has bleached coral reefs, causing enormous harm to ocean ecosystems of which healthy coral reefs are an essential component. And, as captured in this issue's front-page article by Emily Bird of our staff, there is growing evidence that we are experiencing what scientists call ocean acidification.

As one scientist has said, ocean acidification is the "osteoporosis" of the world's oceans. As the oceans acidify, the exoskeletons of marine animals become brittle and frail just as osteoporosis weakens the bones of humans. Acidification can also affect the nervous system, blood circulation, and respiratory functions of fish and other sea creatures. If left unchecked, this fundamental alteration of ocean chemistry has the potential to threaten the livelihood and food security of people worldwide.

The good news globally is that people are coming together to intensify our ocean protection efforts. A significant commitment by all is necessary because what happens in our oceans doesn't stay in our oceans; so many land-related environmental priorities are affected as well. A civil society needs to take the fate of our oceans more seriously—before it's too late.

Sincerely,

Ronald Poltak
NEIWPCC Executive Director

Letters to the Editor

Perplexing Measurement

If you read the April 2013 *IWR*, you may recall a short article on a rare case of welcome destruction caused by Hurricane Sandy. The storm's surge blew out a dike across the mouth of Sunken Meadow Creek in Long Island's Sunken Meadow State Park, allowing tidal flow to be restored to habitat beyond the dike that had long been deprived of regular infusions of salt water from Long Island Sound. The article included a photograph of New York State biologist Ariana Newell checking salinity in Sunken Meadow Creek roughly a month after Sandy. As the caption noted, Newell found the salinity at a point just beyond the creek's mouth to be 35 parts per thousand, more than three times the level typically seen before the dike was destroyed.

Shortly after publication of the issue, we received the following email:

> *I read with interest the article about Sunken Creek. This is indeed good news. However, you might want to check the salinometer used to measure the salinity for the article. The surface water salinity in Smithtown Bay, to which the creek drains, has a salinity of 24-27 PSU. If it was 35 PSU we would be way east.*
>
> *R. Lawrence Swanson, Director*
> *Waste Reduction and Management Institute*
> *and Associate Dean, School of Marine and*
> *Atmospheric Sciences*
> *Stony Brook University, N.Y.*

You may note that Swanson uses PSU in his letter, which stands for practical salinity units, a measurement often used by scientists when expressing salinity. But values of salinity in PSU tend to be nearly equivalent to values expressed as parts per thousand, which Newell used. So it's fair to contrast Swanson's numbers with Newell's. Why then the discrepancy? We asked Newell, who emailed her thoughts:

> *I agree that the readings that day were very high. I even rechecked the calibration on the refractometer that day and retested with the same results. That was the only day of testing that we had readings that high. I don't have an explanation for why. All of the readings since then have been in the normal range for that area of the Sound. The creek is in such a state of change that I can only report what the equipment tells me. Even if we were to discount the readings for that day, I hope the main point is still made: There was a huge change in salinity in the creek once tidal flow was restored, and we are excited for the opportunity to observe the creek as it returns to a more natural state.*

In response to Newell's reply, Swanson wrote that the important thing was that the equipment was checked. He added that phenomena such as the disparity in salinity are what make working in the natural world so interesting. If you have a comment on this situation or anything else you read in *IWR*, please email *IWR* editor Stephen Hochbrunn at shochbrunn@neiwpcc.org.

Field Day

NEIWPCC's IEC District Conducts Sampling… and Much More

By Evelyn Powers, NEIWPCC/IEC District

On July 25, 2013, as the 29-foot *Triton* fishing vessel prepared to depart from Manhasset Bay Marina bound for Long Island Sound, Amanda Rollizo completed final quality control checks of her water quality meter by taking dockside readings of dissolved oxygen, pH, temperature, and salinity. Rollizo is a NEIWPCC assistant environmental analyst at the Interstate Environmental Commission District, which for 23 consecutive years has been doing what Rollizo was heading out to do—collect samples from Long Island Sound and the upper East River to assess hypoxic conditions. Earlier in the summer, the IEC District's sampling runs had been conducted in predictably high heat and humidity. But on July 25, everything felt different.

"Last week was 95 degrees and calm, and this week, it's 55 degrees with five-foot waves," Rollizo said. "The Long Island Sound can be a merciless mistress. Sometimes by the end of sampling I feel like a salty pirate."

The big drop in temperature and the waves didn't interfere with Rollizo's plans. She and a colleague at the time, Nymbat Juramt, headed out into the rough waters to collect samples from a series of stations, samples that will help enhance understanding of the area's chronic issues with hypoxia—that is, oxygen concentrations so low as to be detrimental for most animal life. Gathering the samples and analyzing them on a regular basis is an important job, but then, important work is what the IEC District has been doing for a long time.

Originally formed in 1936, the IEC District has for decades assisted New York, New Jersey, and Connecticut on a wide range of air and water pollution matters. In a recent change, NEIWPCC was named host of the IEC District, but IEC's responsibilities—and the crucial work it does related to point and nonpoint source pollution—remain very much intact. In the point source realm, NEIWPCC staff working in the IEC District assist the states' environmental agencies and EPA in developing a list of facilities prioritized for sampling to ensure compliance with State Pollution Discharge Elimination System (SPDES) permit effluent limitations as well as IEC water quality regulations. This list includes wastewater treatment plants, pump stations, and industrial facilities such as power plants and oil refineries. By working closely with the states, the IEC District is able to focus its resources on facilities where sampling is not performed by other agencies or where there's a history of violations warranting special attention. The district's work on nonpoint source pollution issues includes the sampling in Long Island Sound that Rollizo was doing on July 25. But other nonpoint source initiatives, such as the development of a comprehensive ambient monitoring strategy, are planned to help fill data gaps and resource needs, identify problematic areas, enhance data sets, and measure the effectiveness of implemented management activities and programs.

Since the work is so diverse, a typical day for the staff of NEIWPCC's IEC District may begin anywhere in the tri-state area on sea or on land. When not in the field, the staff is based at the IEC District Laboratory on the campus of the College of Staten Island (part of the City University of New York system). All staff members are expected to participate in sampling and analyses as well as quality control, data entry, and report generation. This expectation of versatility benefits the staff members, the laboratory, and ultimately the area the IEC District serves.

On an unusually brisk July day on Long Island Sound, Amanda Rollizo records water quality meter readings during a sampling trip conducted by NEIWPCC's Interstate Environmental Commission District.

"By working in both the field and the lab," Rollizo said,"we gain a well-rounded understanding of IEC District activities." All the staff not only know where the samples come from but also how they are analyzed and how data are disseminated and reported. This reliance on cross-trained lab and field staff helps ensure collection and analysis are conducted according to established standard operating procedures (SOPs) and EPA-approved Quality Assurance Project Plans (QAPPs)—no small detail. Given the goal of the IEC District Laboratory is to provide qualitative and quantitative data to be used in decision making by regional environmental managers and agencies, it's of critical importance that the data be of the highest quality possible.

The IEC District Laboratory has National Environmental Laboratory Approval Program (NELAP) accreditation granted through both the New York State Department of Health and the New Jersey Department of Environmental Protection's Office of Quality Assurance. NELAP is a national accreditation program through which all entities involved in generating environmental data within the United States are accredited and held to one uniform standard. The laboratory is also certified by the Connecticut Department of Public Health as an approved environmental laboratory. All this accreditation means the lab is fully authorized at the highest levels to test for microbiological parameters such as fecal coliform, *Enterococcus*, and *E. coli*; inorganic chemistry parameters such as metals, solids, and minerals; as well as aggregate organic parameters such as oil and grease, biochemical oxygen demand, and chemical oxygen demand. All the IEC District's work, from sampling and transport to analysis and data review, is carried out according to analyte-specific SOPs conforming with NELAP standards and formatting requirements. Also, as required by NELAP, the laboratory participates in two rounds of proficiency tests for all analyses on its certified parameter list. And the laboratory is subject to biennial on-site assessments by the NYS Department of Health and NJDEP's Office of Quality Assurance.

Through a memorandum of understanding with the College of Staten Island, NEIWPCC's IEC staff also work on water quality research with students and professors in the college's M.S. in Environmental Science program and its Center for Environmental Science. The IEC staff mentor CSI graduate students on thesis research and help train them in environmental fieldwork and microbiological and wet chemistry laboratory methods. Current student research is focused on the measurement of metals and chlorophyll concentrations in the Staten Island Bluebelt, a collection of streams, ponds, and wetlands being preserved by the New York City Department of Environmental Protection as a means of naturally storing and filtering stormwater.

As for Rollizo and her venture out into Long Island Sound on that blustery July day, it ultimately was a case of mission accomplished. After a long day out on the water, she and Juramt safely returned to the laboratory with Chlorophyll *a* samples collected from 22 stations in the upper East River and western

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At the IEC District Laboratory on Staten Island, N.Y., NEIWPCC's Inna Golberg tests water samples for biochemical oxygen demand, a key indicator of water quality.

Under the Radar

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"It's not like finding the grocery store is out of milk, so you purchase soy milk," Green said. "Some species may not be able to quickly adapt and seek out alternative food sources."

Studies have shown that ocean acidification is already dissolving pteropods, snail-like zooplankton that make up the base of the food chain in cold water ecosystems. That's no small matter for creatures higher on the food web. The resulting trophic cascade poses a threat to marine predators such as birds, whales, and juvenile pink and Atlantic salmon, whose diet is 40 percent pteropods.

Historical Roots

As is often argued by climate change skeptics, atmospheric carbon dioxide levels have indeed reached present-day levels throughout Earth's history. But when the subject is ocean acidification and its impact, the *rate* of the increase appears to be the critical factor. Core-sample carbon dating, which is able to show atmospheric carbon dioxide levels over the past 300 million years, reveals that at points in geologic history when carbon dioxide levels elevate at a high rate, fossils of indicator species susceptible to ocean acidification are absent. Contrarily, in periods when carbon dioxide levels elevate at a slower rate, fossils of these indicator species are present.

What makes those findings particularly worrisome is that the rate of carbon dioxide increase and ocean acidification underway now exceeds the rates of ocean acidification correlated with four major extinctions in Earth's history. The only time period having anything like the rate of ocean acidification being observed today was the Paleocene-Eocene Thermal Maximum, 56 million years ago. Sediment cores from the PETM show a total dissolve of carbonate plankton shells, leaving a layer of dead mud (representing 5,000 years) sandwiched between thick deposits of white plankton fossils. With such a massive die-off of species low in the food chain, it is likely that organisms higher in the food chain also suffered. Scientists estimate that during the PETM, pH (the unit measure of acidity) fell 0.45 units over 5,000 years. (A fall in pH means an increase in acidity.) By contrast, in recent history, ocean pH has fallen ten times faster: by 0.1 pH units in only 100 years. In the new *Climate Change 2013* report released in September by the Intergovernmental Panel on Climate Change, the IPCC projects pH may fall another 0.3 pH units by the end of this century if atmospheric carbon continues to increase rapidly. In this scenario, ocean pH would drop roughly 0.4 pH units over just 200 years.

Some more historical perspective: Based on ice core samples from Antarctica, researchers have determined that at the start of the Industrial Revolution, atmospheric carbon dioxide existed at 280 parts per million. Over the past 200 years, that amount has increased to 390 ppm, while at the same time, ocean surface water acidity has increased by 30 percent—the result, according to Green of Saint Joseph's College, of the oceans absorbing 500 billion tons of carbon dioxide.

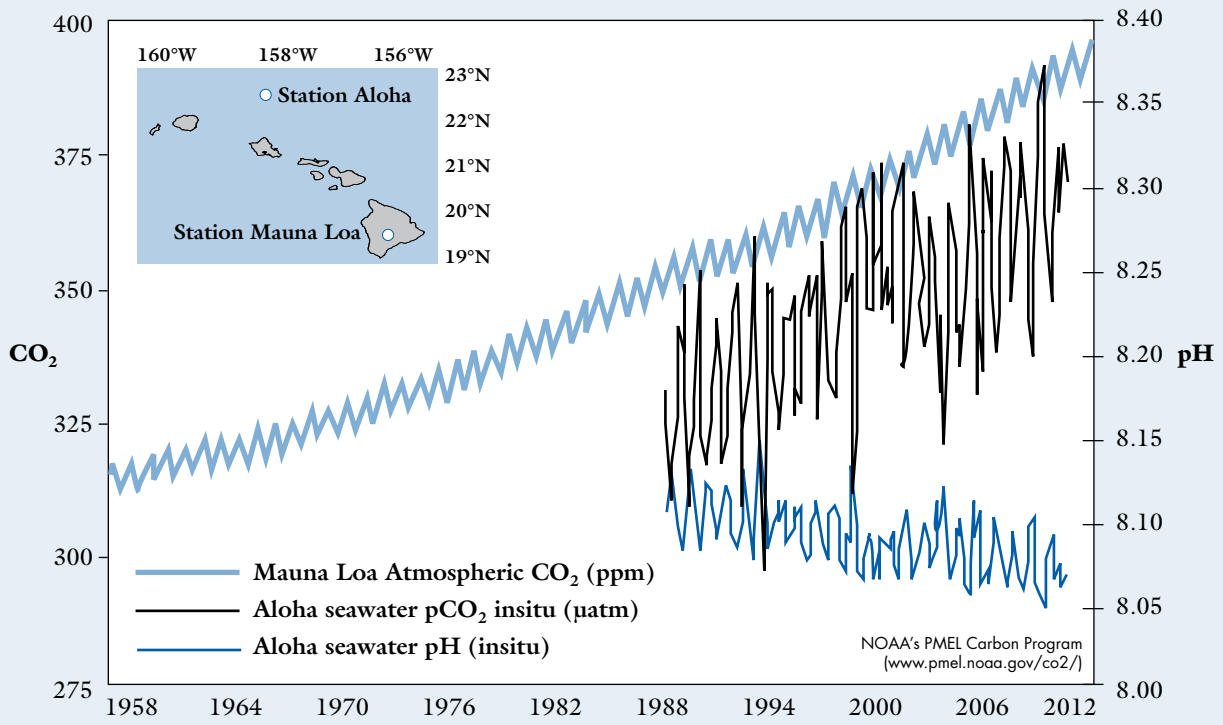
It's important to be aware too that the emissions-to-acidification process takes time—about 50 years to be specific. In other words, the ocean acidification and associated impacts occurring today are the result of atmospheric carbon emissions from the 1960s, a time when atmospheric carbon dioxide levels were 315 parts per million. With atmospheric carbon dioxide today at 390 ppm and increasing all the time —and with the rate of increase also on the rise—it's easy to see why some scientists are so concerned. Fifty years from now, ocean acidification will reflect today's elevated carbon dioxide levels and the impacts will likely be more severe and widespread. According to Green, oceans currently absorb 21 million metric tons of atmospheric carbon dioxide per day, equating to approximately 7.8 billion metric tons per year. But as atmospheric carbon dioxide levels increase, the rate of absorption is expected to increase by 2 billion tons every year.

Regional Risks

One other critical aspect of ocean acidification is that although acidification is occurring in waters across the globe, it's not happening to the same degree everywhere. The level of impact varies by location, and scientists have determined the areas most vulnerable to ocean acidification share certain characteristics:

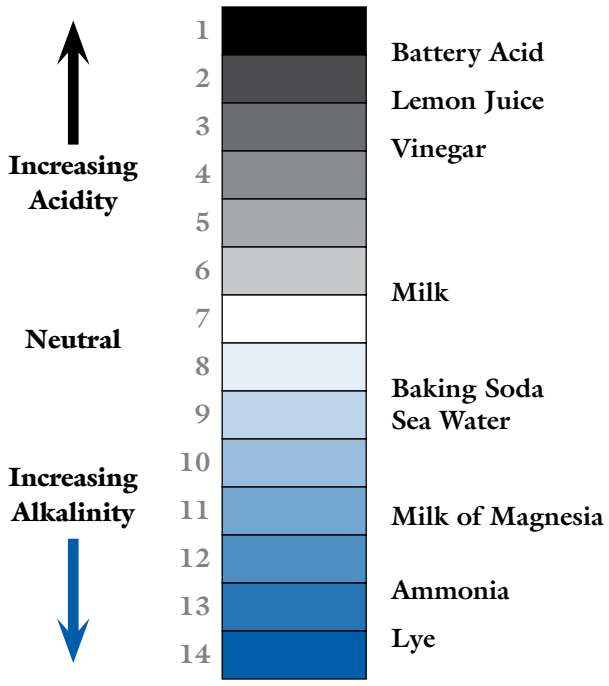
- **Seasonal upwelling:** This occurs when a combination of wind, the Earth's rotation, and restricted lateral movements push surface coastal waters offshore and benthic water—the water at the bottom of the sea—wells up. The benthic water is high in carbon dioxide since it's been out of atmospheric contact and has been accumulating carbon from the decomposition of sinking organic matter under cold temperatures. Upwelling is prominent along the U.S. Pacific Coast, a region where upwelling brings rich nutrients to surface waters and helps create some of the world's most productive and valuable fisheries. But the upwelling also makes the region highly vulnerable to ocean acidification.
- **Cold water temperature:** In the ocean's water column there is a saturation horizon, the depth at which calcium carbonate saturation shifts to being unfavorable for the calcification process. The saturation horizon depends on water temperature; in cold water marine environments, the saturation

CO_2 Time Series in the North Pacific



Data collected at the National Oceanic and Atmospheric Administration's Mauna Loa (Hawaii) Observatory and Ocean Station Aloha reveal a significant increase in the area's atmospheric carbon dioxide since 1958 as well a rise in carbon dioxide in the surrounding waters. A decrease in ocean water pH (increased acidity) has also been observed—no surprise given carbon dioxide combines with ocean water to form carbonic acid, thus driving ocean acidification. Note that the process of ocean acidification—that is, going from carbon dioxide emissions in the atmosphere, to water, and finally the chemical reaction that causes acidification—takes roughly 50 years; so, for example, the level of pH in this graph in 2012 is actually the result of atmospheric carbon levels in 1962. Likewise, current levels of atmospheric carbon will influence ocean pH approximately 50 years from now. (This figure originally appeared in the Proceedings of the National Academy of Sciences of the United States of America.)

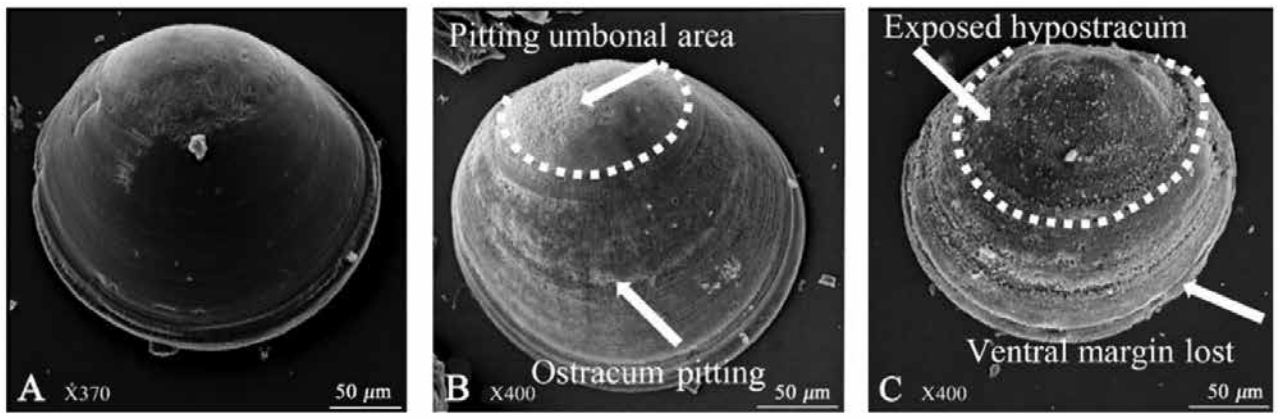
pH Scale



The pH scale ranges from 1 to 14, with 7 (the pH of pure water) being neutral. Substances with a pH of more than 7 are said to be basic or alkaline while those with a pH reading less than 7 are acidic. The lower the reading, the greater the acidity—and the greater the impact on aquatic life. Bear in mind the scale is based on powers of 10, so a substance with a pH of 3 is 10 times more acidic than one with a reading of 4.

horizon is shallower because carbon dioxide is more readily absorbed in cold water than warm. Although the shallower saturation horizon is normal for cold ocean regions, ocean acidification only aggravates matters, further reducing the calcium carbonate formation so necessary to build shells. Ecosystems in cold water ocean regions are therefore highly susceptible to the impacts of ocean acidification, as is already being seen in the impact on shell formation and survival success of pteropods.

- **Eutrophication:** Coastal regions with excessive nutrient input, usually from wastewater treatment, urban stormwater, and agricultural runoff, are susceptible to excessive algae production. When algae die, the decomposition requires respiration that, like human breathing, uses oxygen and emits carbon dioxide. Coastal waters that frequently experience elevated carbon dioxide levels from eutrophication—and there's no shortage of such waters off the shores of New England and New York—are hence more vulnerable to acidification.



M. Green, Saint Joseph's College

Day 0 **Day 4** **Day 7**

These clam images, provided by Mark Green of Saint Joseph's College in Maine, capture one of the end results of excess carbon dioxide in marine conditions. Because carbonate ions combine more readily with hydrogen ions than with calcium ions, the result is more carbonic acid and less calcium carbonate. When the calcium carbonate saturation state in the water column is less than 1.0, calcium carbonate minerals, so necessary for shell formation, begin to dissolve. The above photos of clams (0.2 mm size class) show the dissolution of shells that occurs over seven days at a calcium carbonate saturation state of 0.6, characteristic of an acidic environment.

Seas of Vulnerability

While the Pacific Northwest, a region characterized by seasonal upwelling, appears to have been the first area in the United States to see impacts from ocean acidification, the effects in the Northeast Atlantic (where eutrophication is common) are increasingly visible, specifically among calcifier species such as shellfish and certain zooplankton species. Studies show that larval lobsters are very susceptible to increased acidity; effects of this exposure at the larval stage include slower growth rates and softer shells and less meat as adults. Copepods, a zooplankton at the base of the food chain, show lower fecundity (reproductive capacity), which of course impacts the diet of species in higher trophic levels.

Among the most heavily impacted shellfish species are mollusks, which are not only extremely valuable to the seafood industry but also invaluable to the ecosystem—not least because of their ability to filter material such as silt and algae from water. According to Green, studies show hard-shell clams, soft-shell clams, and bay scallops are highly susceptible to increased acidity, while oysters are slightly more resilient. The reason for oysters' greater resiliency isn't known, but any advantage is welcome, given oysters' perilous state. It is estimated that 85 percent of global oyster populations are functionally extinct, meaning that in most areas, they no longer play a significant ecosystem role.

Research has also shown that although shellfish are impacted by ocean acidification throughout their lifecycle, the most severe impact is in the larval stage—a stage that even without acidification is the time of greatest vulnerability to predation. The larval stage, in which a shellfish is without its protective shell, usually lasts up to two weeks. But in an acidic environment, the restricting or slowing of the calcification process necessary to build a shell means the larval life stage is prolonged, further reducing the chances for survival.

Later in a shellfish's life, acidification can cause more problems. If a larval shellfish survives into young adulthood, it settles to the ocean floor. But, as happens frequently, the youngster may decide it's unhappy with the surface on which it's living—that is, its substrate, to use the biological term. If the shellfish rejects the substrate, it has about 24 hours to relocate by projecting itself back into the water column to resettle in a new location. Green said that before shellfish harvesting and ocean acidification, this relocation process was relatively easy, because shells from past generations were an "environmental prerequisite," providing a calcium carbonate buffer between any acidic mud and the shellfish. As a result of harvesting (and overharvesting) and ocean acidification, it is difficult in some regions for shellfish to find a suitable substrate. If a shellfish doesn't find an ideal location within 24 hours, it may have no choice but to settle in an acidic environment. In such environments, shellfish dissolve to some degree and experience slower development, higher mortality, and decreased fecundity.

A Dissolving Fishery?

Given all the environmental impact from ocean acidification, what is at stake economically? A great deal, to put it mildly. A 2010 report from the National Marine Fisheries Service put the value of landings—the part of the fish catch brought ashore—in the 50 states at $4.5 billion. The report added that U.S. consumers spent roughly $80.2 billion for fishery products and that the commercial fishing industry contributed $41.4 billion to gross national product.

The species with the most value economically include crabs, salmon, scallops, lobsters, and shrimp—all either calcifying species or their predators. The Northeast and New England fishing industry's heavy reliance on these species explains why the region's ports are some of the most economically important in the nation. (Northeast ports generate 20 percent of the industry's revenue nationwide from just 8 percent of the commercial landings by weight). But that reliance on high-value species also explains the growing concern for fishing in our region as more is learned about the impact of ocean acidification.

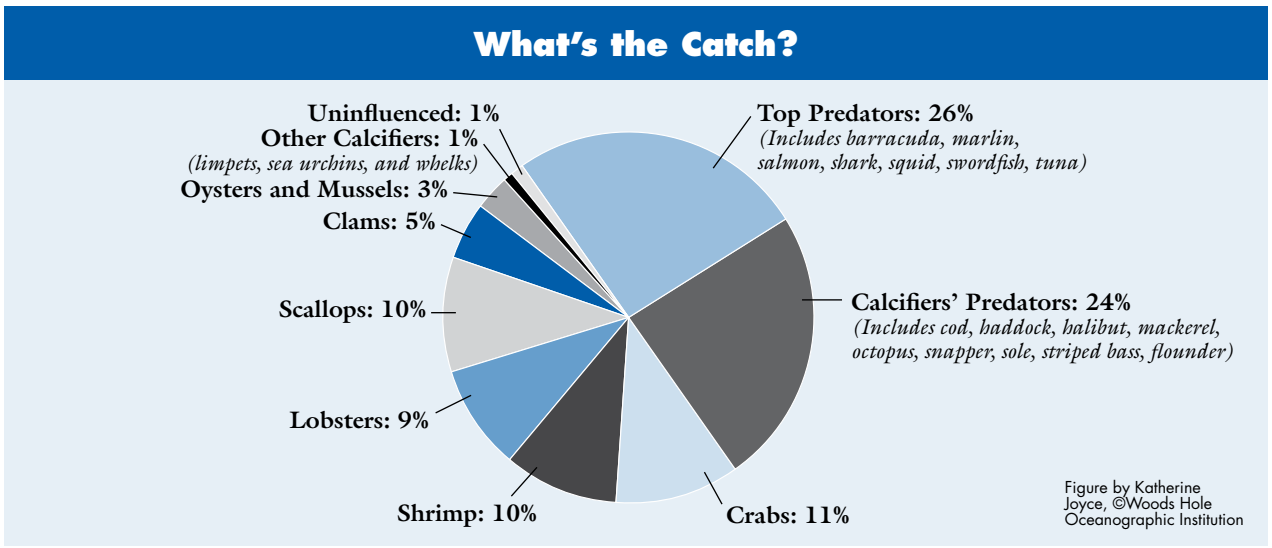
Precisely what will unfold from ocean acidification is uncertain and depends on the species' ability to adapt. But in an interview with Sarah Cooley, a research associate at the Woods Hole (Mass.) Oceanographic Institution, she said, "What we can say with a good deal of certainty is that New England's heavy economic and cultural dependence on potentially ocean acidification-vulnerable species suggests that the area could be strongly affected by ocean acidification."

Research published by Cooley and Scott Doney of Woods Hole in 2009 explored the economic impact of ocean acidification based on carbon projections by the Intergovernmental Panel on Climate Change. The IPCC has predicted an increase in atmospheric carbon dioxide from 390 ppm to 700 ppm by 2060 in a high carbon emissions scenario; even if carbon emissions are somehow reduced to what the IPCC calls its low carbon emissions scenario, the increase to 700 ppm will happen by the end of the century. As Cooley and Doney show in their report, that's a problem on many levels, including for shellfish and those who make a living from them. Laboratory experiments have shown that carbon dioxide at 700 ppm is associated with a 10-25 percent decline in mollusk calcification rates, which would likely translate into a 10-25 percent revenue loss for economically vulnerable coastal communities.

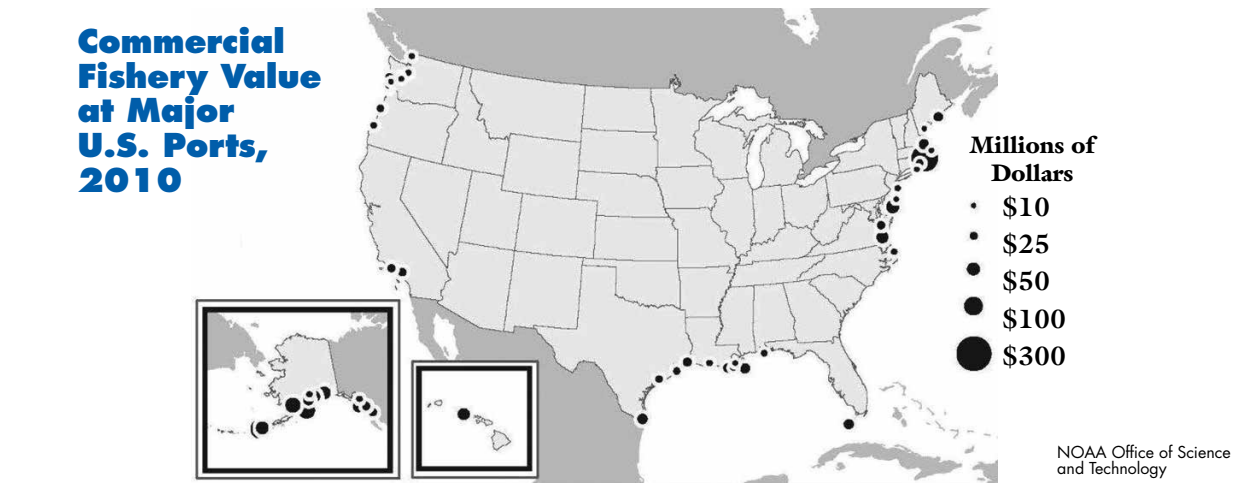
The economic impact will be felt first and foremost by mollusk-dominated fisheries, and one of the world's biggest is just 80 miles from NEIWPCC's Lowell headquarters. For much of the past decade, New Bedford, Massachusetts, has claimed the highest value of landings among U.S. fishery ports, with scallops making up 77 percent of the landings. In New Bedford, a 25 percent reduction in scallop production would equate to a $60 million loss in revenue annually—a devastating economic blow to the community. The threat of that level of impact is something policymakers may not be able to ignore. As Cooley and Doney wrote in their report, "The worldwide political, ethical, social, and economic ramifications of ocean acidification, plus its capability to switch ecosystems to a different state following relatively small perturbations make it a policy-relevant 'tipping element' of the earth system."

Policy Conundrum

Ocean acidification is a water impairment caused by air pollution, placing it at the regulatory intersection of the federal Clean Water Act and Clean Air Act. Further complicating prospects for crafting policy to address ocean acidification is that, like global warming, it's a classic example of the "tragedy of the commons," where self-interest drives depletion of a shared resource even though the depletion is in nobody's long-term interest. In a time of squeezed government budgets and political gridlock, can we really expect lawmakers from land-locked states to vigorously push policy to address a problem that economically has a disproportionate impact on coastal communities? A global pool of carbon emissions is impacting our oceans on a global scale,



The Woods Hole Oceanographic Institution chart above shows the breakdown of the catch by U.S. commercial fisheries in 2007—and illustrates why there's growing concern for the fishing industry. On the left side, making up roughly half the catch, are the shell-making calcifiers, the species most vulnerable to the effects of ocean acidification. But note that the species on the right, which likely are not directly affected by increased acidity, could nonetheless feel the impact due to the effect on their prey. (The top predators eat the calcifiers' predators.) The NOAA map below shows the important role that fishing plays in the economies of certain areas, including many coastal communities in NEIWPCC's member states. The largest dot on the map corresponds to New Bedford, Massachusetts, where landings had a value of $307 million in 2010. Scallops, which are well known to be affected by increased acidity, accounted for three-quarters of New Bedford's 2010 landings.



but the outlook for addressing ocean acidification in the United States at a state or national level is uncertain.

Despite the complications, one organization—the Center for Biological Diversity (CBD)—rolled up its sleeves in 2007 to push to address ocean acidification under the Clean Water Act (CWA). Miyoko Sakashita, CBD's oceans coordinator, said a lot of progress has been made since then, given that not long ago many in the water quality world had never heard of ocean acidification. "CBD has been able to educate water quality management on the issue," Sakashita said. Getting there required taking some tough steps.

CBD first petitioned EPA to strengthen marine pH water quality standards, then filed suit against the agency for failure to address ocean acidification under the CWA. CBD also petitioned coastal states to declare waters as impaired or threatened by ocean acidification under the CWA and to strengthen marine pH water quality standards to 6.5-8.5 pH, as recommended by EPA. As a result of CBD's actions, EPA agreed to consider ocean acidification under the CWA and recommended that coastal states begin to gather data on ocean acidification, develop methods to identify ocean acidification, and create criteria for measuring the impact of ocean acidification on marine ecosystems. At the same time EPA requested public input for addressing ocean acidification under the CWA.

In response, NEIWPCC submitted a comment letter to EPA on behalf of our member states, which all shared the concern that the CWA's impaired waters law isn't the appropriate avenue to address ocean acidification. Here's why: Under the impaired waters law, a waterbody is listed as impaired if it fails to meet the water quality standards necessary to support its designated uses. In the case of ocean acidification, if marine pH falls below the water quality standard recommended for a designated use, such as commercial fishing, a body of water would be considered impaired, resulting in the need for a Total Maximum Daily Load (TMDL) to limit the load of carbon dioxide pollution. In our comment letter, we expressed concern about the burden placed on coastal states lacking the data, expertise, and resources to develop a TMDL for ocean acidification.

It's that paucity of knowledge that poses the problem. Several years ago, NEIWPCC led the effort to use the impaired waters law to develop the Northeast Regional Mercury TMDL, which successfully put pressure on EPA to act on mercury being deposited in Northeast waters from sources outside the region. But back then, we and our member states were on solid ground with all aspects of the mercury issue. While in theory ocean acidification could be addressed under a similar regional approach, the reality is the two situations are not the same.

"We had a large dataset of mercury fish tissue concentrations, a model to follow, and expertise in-house," said Susy King, NEIWPCC's director of water quality programs, who played a major role in the development of the mercury TMDL. "We do not have a dataset to determine impairment for ocean acidification."

King appreciates the efforts by CBD and EPA but feels it's all more than the states can handle at the moment. "While it's not out of the question, a TMDL is not the favored approach at this time for ocean acidification," she said. "There are just too many unknowns, and there may be little benefit from trying to address this global air pollution problem with a Clean Water Act tool."

Work to Do

The policy complications related to ocean acidification make one thing perfectly clear: We have a lot to learn. The Northeast states recommend that EPA develop a robust monitoring program, going further than what individual state resources would allow. The resulting pH monitoring data, coupled with data on emission sources and atmospheric deposition, would help immensely in the development of national and international strategies.

In a discussion of ways to better understand the impacts of ocean acidification, Cooley of Woods Hole pointed to the shellfish hatcheries in the Pacific Northwest. "These hatcheries are teaming up with university and federal scientists to improve monitoring for physical conditions that worsen acidification," Cooley said. Through the monitoring network, scientists more fully grasp the impact of ocean acidification on Pacific oyster larvae and the physical conditions that worsen the effects. When these conditions are detected, hatcheries can take protective measures to protect their oyster larvae.

"The 'recipe' for New England would probably be different [than for the Pacific Northwest] because of the different mix of stressors, species, and uses of those species here," Cooley said. But what's important is not the specific approach but what it represents. "It seems as though solutions for dealing with ocean acidification come from innovative thinking, developing partnerships between groups that may not already be working together, and objective analysis of what tradeoffs are acceptable to maintain a valuable resource," Cooley said.

To further narrow information gaps on ocean acidification, Cooley said the scientific community must first learn exactly what acidic conditions can be tolerated by our most important marine species. Most current science on the impact of increased acidity is based on laboratory experiments, but lab work doesn't necessarily capture the effects in the marine environment or replicate influences on wild populations and large-scale population dynamics. By conducting fine-scale longer-term experimental studies, the findings will more closely represent the real impact of ocean acidification on marine resources.

"As we uncover that information, I hope we can pass it along to decision makers so they can weigh the costs and benefits of different management options," Cooley said. "They can consider whether to enhance or protect aquaculture, encourage greater diversification of harvested species, or some other alternative."

In the meantime, it may be possible to curb the impact of ocean acidification by making waters more resilient to increased acidity, thereby minimizing the effects. Addressing nutrient contamination at a watershed scale helps reduce eutrophication that may otherwise trigger earlier or more severe ocean acidification impacts. Saint Joseph's College's Green

has developed another feasible mitigation technique, which he calls a "local Band-Aid approach": restoring acidic mud flats (characteristic of eutrophic regions) with crushed shells to increase calcium carbonate, reduce acidity, and provide a suitable substrate for shellfish. This model has been followed in many coastal communities, and with further development may be a cost-effective, commercially viable way to increase shellfish populations.

But mitigation only goes so far. As stated in NEIWPCC's comment letter, "Where the environment is concerned, prevention will always be a more successful avenue than restoration or rehabilitation." Ocean acidification will continue at an ever-increasing rate absent addressing the source of the problem: carbon dioxide emissions. With such sensitivity around that issue, ocean acidification is facing the same political barriers as climate change. The easy choice would be to set aside ocean acidification due to its political ramifications, daunting scale, and lack of historic monitoring. That, however, would be a mistake.

"The science of ocean acidification is not based on elaborate models," Green said. "Simple monitoring has provided clear evidence that the oceans are growing more acidic and that the change is adversely impacting coastal ecosystems. To deny ocean acidification is like saying 'I don't believe in gravity.'"

* * *

Emily Bird (ebird@neiwpcc.org) is a NEIWPCC environmental analyst. She manages NEIWPCC's total maximum daily load (TMDL), Long Island Sound TMDL, and mercury programs. Emily also serves as project manager for NEIWPCC's partnership with the Peconic Estuary Program and chairs the NEIWPCC Sustainability Committee.

Trade Talk

continued from page 1

can receive and still meet its water quality standards. A TMDL includes wasteload allocations (WLAs) that outline precisely how much of a pollutant can come from a point source or group of point sources, and these WLAs are used as guides in developing National Pollutant Discharge Elimination System (NPDES) permits for facilities that discharge to the water body of concern. NPDES permits put specific and sometimes stringent limits on the amount of things such as total suspended solids and nutrients in a facility's effluent—and meeting these limits can be expensive. As for nonpoint sources, they're not regulated under the Clean Water Act but are still considered in a TMDL; a nonpoint source or group of nonpoint sources is assigned a load allocation (LA) that spells out the amount of a pollutant they can contribute to the water body—and if reductions must be made, they often can be done less expensively than at a point source. All this helps explain what makes water quality trading so attractive.

On a basic level, the system is comprised of the three most fundamental market elements: a seller, a buyer, and a commodity. In water quality trading, the commodity is any form of water pollution, ranging from sediment and nutrient runoff to thermal pollution. But what is really being traded is a reduction in the amount of pollution discharged. Any set amount of pollution reduced beyond a source's WLA or LA can be referred to as a "credit," which the source may then sell to a buyer that gets the credit for the pollutant reduction. To explain how this works in practice, consider the simplest scenario: a trade between point sources.

Imagine two wastewater treatment plants, called Plant A and Plant B, both located in the same general vicinity and both discharging to a river that flows into a water body for which a TMDL has been developed. The TMDL requires the plants to make a combined 1,000 pound reduction in a pollutant; if split equally, each WWTP would have to reduce its effluent concentration by 500 pounds. But assume Plant B can make the necessary changes far less expensively than Plant A can. With a water quality trading program in place, Plant B could install facilities to reduce its load by the entire 1,000 pounds, thus producing credits equal to 500 pounds of pollutant removed. Plant A could then buy these credits from Plant B and meet its obligation under the TMDL (and associated NPDES permit). For the trade to work, it has to be cheaper for Plant A to buy the credits than to reduce its own discharge of the pollutant.

While cost savings may be the motivating factor in such a trade, the environment is the beneficiary as the desired pollutant reduction is achieved. And since both sources are already subject to discharge permits and their monitoring requirements, an excellent mechanism is in place to ensure the trade agreements are met. Because of this inherent ability to monitor discharges and to specify requirements in binding legal documents, point source-to-point source trading works—and just how well it works can be seen in an example from our own region.

Scientists have long been alarmed by low levels of dissolved oxygen in the waters of the western half of Long Island Sound—and the blame falls squarely on the excessive discharge of nitrogen from human activities. (Nitrogen triggers the growth of algae, which consume oxygen when they decay.) In 2001, Connecticut and New York, working with EPA, completed a TMDL that identified the maximum amount of nitrogen the Sound can handle—and one year later, Connecticut's environmental agency launched the Nitrogen Credit Exchange to help wastewater treatment plants meet the TMDL's nitrogen limits. The exchange provides an efficient means of trading nitrogen credits among 80 treatment plants in Connecticut, and its success is undeniable. The plants buy and sell millions of dollars of nitrogen credits every year while the total discharge of nitrogen from the plants continues to fall as nitrogen removal projects are finished. Connecticut's aggregate nitrogen load from wastewater treatment plants is now very near the limit established in the TMDL.

Getting to the (Non) Point

Trading between point sources and nonpoint sources is also simple—in theory, that is. Instead of a point source, such as a wastewater treatment plant, generating credits, a non-point source, generally a farmer or forester, generates credits by implementing what the Clean Water Act calls Best Management Practices. A BMP is any practice that reduces a specific source of nonpoint source pollution, typically in the form of runoff reduction. The nonpoint source pollution could be pesticides, fertilizers, or waste from agricultural locations or it could be sediment caused by rain washing soil away from freshly plowed fields, deforested land, or logging roads. Common BMPs include using slow-release nutrients, planting cover crops to hold soil on a field after harvest, and retaining (or planting) trees on embankments for stabilization and shade.

BMP implementation can lead to a myriad of environmental benefits—and it's cost-effective too, when compared to the expense of installing new equipment and technology at a point source. EPA has estimated

Bill Howland, NEIWPCC/LCBP

In 2008, the rain-swollen Lamoille River, colored brown by sediment runoff, flows through farmland in northern Vermont. In much of the country, it's common to find a farm's fields extending right to the banks of a river, which can transport contaminated runoff from cropland to water bodies overburdened by pollutants. Nonpoint-to-point water quality trading programs rely on nonpoint source pollution sources such as farms to achieve pollutant reductions through the implementation of Best Management Practices, such as the buffers of trees seen here lining portions of the Lamoille. The pollutant reductions are quantified and sold as credits to point sources looking to less expensively meet permit targets. Critics argue such trading lets point sources buy the right to avoid making treatment improvements; trading advocates counter that the desired pollutant reduction is still achieved—and at less cost.

that reducing nonpoint source pollution from farming could result in savings of some $15 billion in capital costs for tertiary (advanced) water treatment. Real-world examples support that claim. In Pennsylvania, the Mount Joy Borough Authority, which provides water and wastewater service to several towns, funded no-till practices at a local farm as a means of meeting the authority's permit cap for nitrogen. The cost: $3.81 per pound of nitrogen runoff reduced. Had the authority invested instead in physical upgrades at its wastewater treatment plant, the cost would have been $12 per pound.

A nonpoint source trading program provides multiple other advantages: a higher degree of sustainability, since BMPs help to prevent a pollutant from even entering the environment; ancillary benefits such as healthier soils, stabilized embankments, and improved habitats; some degree of control by regulators over non-urban nonpoint source contributions, which are currently unregulated; and increased collaboration among farmers, environmental groups, regulators, and other stakeholders. In fact, EPA has conservatively estimated that trading between nonpoint sources and point sources could be effectively utilized in at least 900 watersheds across the United States. With all these benefits, why is nonpoint-to-point trading in its infancy while point-to-point programs are so well established? A look at past and current pilot nonpoint-to-point programs from around the country illustrates one likely explanation: While the trading is simple in theory, it's all rather complicated when put into practice.

Factors for Consideration

In any market, the most important requirement is an economic driver, and when the market exists in the environmental world, regulations typically initiate the push. (Most entities aren't inclined to voluntarily incur costs of any sort.) As noted in our Plant A-Plant B scenario, the first motivating factor in a successful water quality trading program is usually a TMDL—and the associated point-source permits that require reductions in discharges of a pollutant. As a notable example, the nutrient trading programs implemented by states in the Chesapeake Bay watershed are entirely based on using the WLAs in the Bay's TMDL as a "cap" on nutrients that must be met. In fact, in a few state handbooks on water quality trading, a water body is required to have a TMDL before being considered for a trading program.

In water quality trading, the regulations also result in establishing a clear buyer and seller. Since sources of nonpoint source pollution aren't subject to discharge permits, the buyer will always be a point source, which is motivated to buy credits because of the cost savings. But here's where complications set in. For a water quality trading market to succeed, there must not only be demand for credits but also an adequate supply. And EPA requires that credits be generated before or during the same period when a buyer uses them to comply with its discharge permit. When sources of nonpoint source pollution, especially agricultural, can't physically generate the credits required within the timeframe of buyers, trading is impeded. This is no minor consideration in areas that undergo extreme seasonal changes, such as New England.

Factors also exist that reduce the monetary value of nonpoint-to-point trading. The costs involved in setting up a water quality trading program are considerable, and securing funding is perhaps the greatest challenge. In a Q&A-style research report conducted for EPA, the participating parties cited initial costs as a universal detriment to even considering a water quality trading program. The costs begin with the necessity of determining whether the potential for a trading market exists at all. To make this determination, EPA's *Water Quality Trading Assessment Handbook* (available at water.epa.gov/type/watersheds/trading/handbook_index.cfm) suggests a list of steps, including creating a watershed loadings profile (a precise detailing of the types and forms of pollutants entering a water body from its watershed), examining the potential for aligning the timing of credit supply and demand, and analyzing all previous data to complete the picture of pollutant suitability for a trading scenario. EPA has no requirements for who does all this work, but generally it will be performed by a third-party consultant—seldom an inexpensive proposition.

If you're familiar with TMDLs, you may be thinking that some of the detailed watershed information may already have been generated through the TMDL process. True, but the information developed for a TMDL only goes so far. While trading program startup costs vary by location, market type, and trading framework, the preliminary work that must be done before credits are bought or sold comes with a price—and it can be significant. An analysis by the environmental consultant Kieser & Associates of Ohio's well-regarded Great Miami River Watershed nonpoint-to-point pilot program found the startup costs to have been roughly $3.6 million over five years. Part of the cost came from modeling, in which sophisticated computer programs are used to mathematically simulate the quantity and movement of pollutants within a watershed. For the Great Miami River program, modeling was done using the Soil and Water Assessment Tool (SWAT) model within EPA's Better Assessment Science Integrating Point and Non-point Sources (BASINS) platform.

Modeling tends to be expensive however it's done. For the Ohio River Basin nonpoint-to-point pilot program, the successor to the Great Miami River program, the modeling tool of choice has been the Watershed Analysis Risk Management Framework (WARMF), available as a download from EPA. In an interview for this article, Greg Youngstrom, an environmental specialist at the Ohio River Valley Water Sanitation Commission (ORSANCO), said the modeling effort has cost just over $1 million and consumed nearly 20 percent of the Ohio River Basin program's total funding.

Lessons learned from the Ohio River Basin program are particularly relevant because the program is one of the most documented, complete approaches to setting up a nonpoint-to-point water quality trading program ever undertaken, with the primary objective being to create a blueprint for a sustainable and economical market. There are also distinct parallels to a potential program in our region. The Ohio River Basin program is a collaborative effort between state agencies, the Electric Power Research Institute, and ORSANCO, an interstate commission that resembles NEIWPCC in many respects. And it involves cooperation and trading between multiple states—Ohio, Indiana, and Kentucky—much as a Northeast program would.

In the interview with Youngstrom, he addressed the financial impact of another essential task: maintaining a water quality trading market. Because a nonpoint-to-point program has never actually existed beyond a pilot stage, substantial data doesn't exist on the costs associated with sustaining a program. But for any water quality trading program to be sustainable, monitoring must be done regularly to ensure that TMDL limitations are being met and that BMPs are reducing load contributions by the calculated amount. An organization must collect and maintain the data and get the information to the appropriate legislative and regulatory bodies. For the Ohio River Basin program, local soil and water conservation districts collect the data, with the generated credits from various sources posted and tracked via an online database called Markit. The cost for developing the database: another $1 million. There certainly are costs associated with maintaining the database as well, though Youngstrom didn't specify them. He did, however, stress how important it is that a high volume of trades be conducted—the better to mitigate the program's overhead costs.

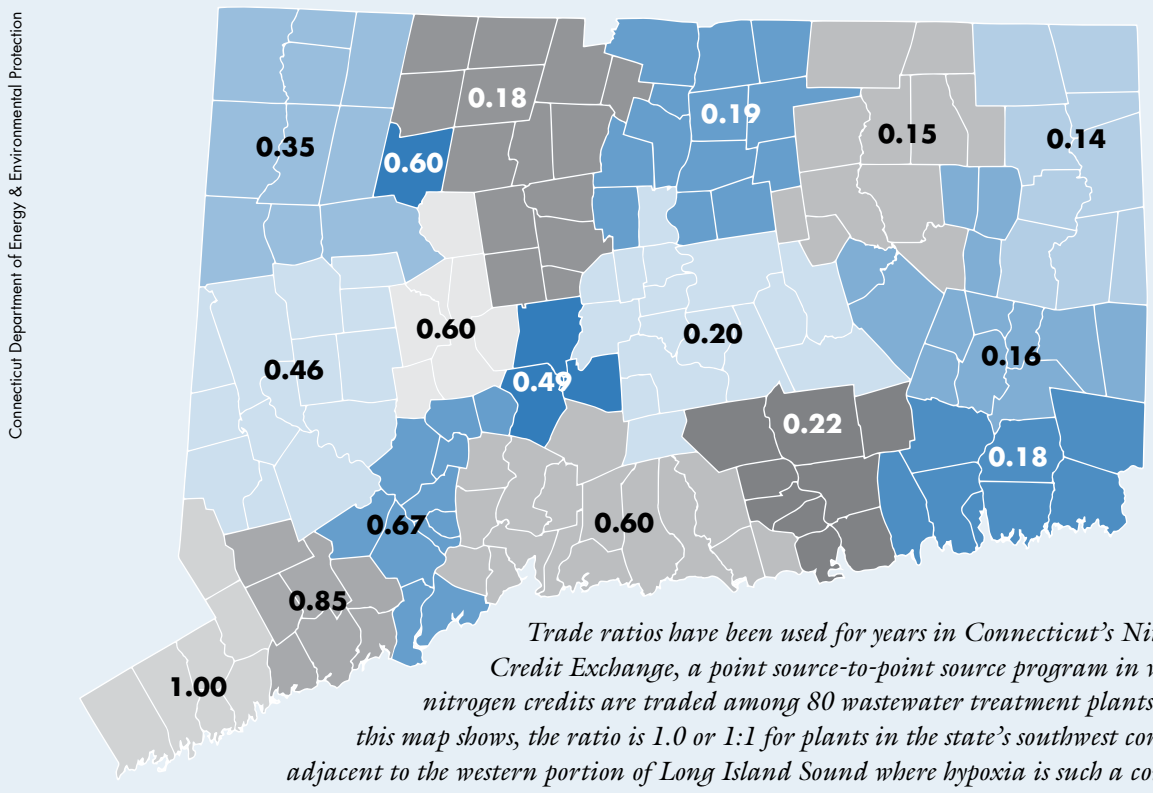
The Cost of Fairness

The use of trade ratios in water quality trading also adds complications and costs. Trade ratios take into account what happens to a pollutant as it enters and travels through a water body. To explain how they would apply in a nonpoint-to-point market, consider again the Plant A-Plant B scenario, where Plant A wishes to minimize the cost of reducing its effluent concentration of a pollutant by 500 pounds. But this time, consider two additional details. First, imagine Plant A discharges its effluent very near the mouth of the river that empties directly into the water body of concern—that is, the water body that's the subject of the TMDL which prompted the plants' required pollutant reductions. Second, imagine a nonpoint-to-point market exists through which Plant A can avoid costly treatment enhancements by buying credits from either of two farms that have implemented BMPs that reduce discharge of the pollutant. One farm is located very near Plant A while the other farm is 50 miles upriver.

The distance between the farms is a crucial distinction, and here's why: As pollutants travel downstream, some of the concentration is naturally attenuated by plants and organisms or absorbed by sediment. So BMPs at the upstream farm that result in a 500-pound reduction won't have the same beneficial impact on the water body of concern as a 500-pound reduction at Plant A. Trade ratios capture this disparity. The trade ratio for the zone in which Plant A and the nearby farm are located would likely be the highest possible at 1:1, since any reductions would have the maximum effect on the water body of concern. The trading ratio for the zone in which the upstream farm resides would be lower, say 1:2 or 0.5. That means that, to buyers, the upstream farm's reductions have only half their value. So, to get its 500-pound reduction, Plant A would have to buy 1,000 pounds of credits from the upstream farm. If, however, Plant A buys from the farm next door, it need only buy credits in the amount of the reduction it needs—500 pounds.

It all makes good sense, environmentally. The benefits to the water body of concern are the same whether Plant A makes the reductions or the nearby farm. But reductions at Plant A and the farm upriver have different impacts—significantly lesser in the case of the farm. But trade ratios, while environmentally beneficial, require an incredible amount of field testing and analysis to derive correctly. And when there are insufficient field data, there's uncertainty in the process. Also, in cases where the only available credits are from nonpoint sources with lower trading ratios, the cost advantages that such a trading market offers to point sources potentially begin to dissipate. (*Potentially* because the selling price of a credit is fluid in most markets, with the price reached in negotiations

Nitrogen Trading Zones



Connecticut Department of Energy & Environmental Protection

Trade ratios have been used for years in Connecticut's Nitrogen Credit Exchange, a point source-to-point source program in which nitrogen credits are traded among 80 wastewater treatment plants. As this map shows, the ratio is 1.0 or 1:1 for plants in the state's southwest corner, adjacent to the western portion of Long Island Sound where hypoxia is such a concern. This means nitrogen reduction credits generated in this area hold 100 percent of their value when traded. So, if a plant anywhere in Connecticut needed to reduce its nitrogen discharge by 500 pounds—and didn't want to make the reduction itself—the plant could satisfy its permit by buying 500-pounds worth of credits from a plant in the 1.0 area. However, the plant would have to buy roughly seven 500-pound credits from a plant in the .14 area (7 x .14 = .98). States carefully craft ratios to capture the disparity in the impact of a pollutant reduction on the water body of concern. Since a plant in the .14 area is located far from western Long Island Sound, much of the nitrogen in the plant's discharge would never make it to the hypoxia-afflicted area anyway, due to natural attenuation.

or a bidding process.) Still, the consensus in the environmental community is that the positives associated with trade ratios far outweigh any drawbacks. As with every aspect of starting up and maintaining a water quality trading program, what's essential is collaboration among all the stakeholders involved.

Areas of Concern

No designated sources of funding exist to finance creating the framework for a successful water quality trading program, so the various pilot projects around the country have had a diverse range of sponsors, from private companies to local, state, and federal agencies. The Ohio River Basin project is funded by power companies, academic institutions, farming organizations such as the American Farmland Trust, and federal grants from EPA and the U.S. Department of Agriculture. In an interview, David Bailey of the Electric Power Research Institute said the project has received about $7 million in total funding to date.

Getting that kind of money isn't the only obstacle. The lack of detail in EPA's Water Quality Trading Policy Statement has led many parties, especially overburdened permit writers, to opt against exploring trading as an option, especially trading involving nonpoint sources. EPA gives virtually all legislative power on this issue to the states, giving them considerable freedom to develop regulations on water quality trading as long as they comply with the Clean Water Act. The most visible role for EPA exists in the approval of TMDLs and, in some states such as Massachusetts and New Hampshire, the issuance of NPDES permits. (Most states issue the permits themselves.) Even in that limited role, many trading advocates find EPA to be lacking. While a TMDL is not a requirement for a trading program, it's widely considered to be integral, and as a result, those involved in setting up trading programs looked to EPA to expedite the laborious TMDL process. Thankfully, in 2006, EPA did say TMDLs can be developed with imperfect data and analytic techniques as long as the state is committed to future revisions as more information is collected.

It's also true that EPA's approach—to have states handle their own water quality trading market regulations—has its benefits. Each state can customize its framework and rules to fit its needs, based on geography and local stakeholder interactions. State control also allows for a more nimble and proactive process. To demonstrate variations between state approaches, the World Resources Institute published a report in 2011 that analyzed the Chesapeake Bay states' programs in categories such as point source participation requirements, market functionality, trading ratios, and compliance and enforcement provisions. In most areas, the states have similar requirements. But specific and significant differences exist. Virginia, for example, doesn't allow sediment credits to be traded, while they're permitted in Maryland, Pennsylvania, and West Virginia. Another example: Pennsylvania and West Virginia allow BMPs financed through cost-share funding to generate credits; that's not the case in Maryland and Virginia.

While such differences have no impact when trading is done within a state, the effect is felt in an interstate marketplace. Greater progress is made toward cleaning up a water body shared by more than one state when there's flexibility for trading to be done across state lines. When there are differences between state regulations, they must be reconciled. While this is certainly possible, it creates yet another challenge—one most easily met with a little outside help.

Independent Authority

While there are many ways to set up the framework for a credit trading market, the most feasible (and consequently popular) method is the third-party method, in which a broker acts as an intermediary between all parties. Getting the right broker is crucial, as the best ones are both unbiased and fully trusted by all—and have the authority and ability to operate across an entire watershed. Brokers need scientific expertise and a great capacity for program administration so they can do everything from assisting in the determination of trade ratios to managing all a program's required reports. They must have strong relationships with all market stakeholders, including community-based watershed organizations, and a deep understanding of community water resources priorities. A broker must be able to help build the public awareness and support so necessary for the success of a water quality trading program.

The importance of awareness and support can be clearly seen in the legal situation currently faced by EPA, which is facing a lawsuit filed by the environmental groups Food & Water Watch and Friends of the Earth over the nonpoint-to-point trading provisions in the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment. The groups argue that the trading will allow established polluters—point sources such as power plants and wastewater treatment plants—to buy the right to continue to pollute by purchasing unmonitored and unverified credits from nonpoint sources, primarily farms. It's a familiar argument used against all cap-and-trade approaches, and in this case, it has some merit. Pollutant reductions by nonpoint source BMPs can be difficult to quantify. But it's not impossible. And trading adherents argue that any approach that provides a financial incentive to address the intractable problem of polluted agricultural runoff is an approach worth taking. What's important is buy-in from all stakeholders, including environmental groups, as a program is being developed, and that's where the right broker plays such an important part.

The broker acts as a hub between groups on both the nonpoint source and point source sides as well as between legislative and regulatory entities. For the Great Miami River program, the broker is the Miami Conservancy District, which works closely with treatment plants, farms, the Ohio Department of Natural Resources, the Ohio Water Environment Association, the Ohio Farm Bureau Federation, county soil and water conservation districts, USDA, and community-based organizations. Between all the parties, communication is key. The soil and conservation districts and the Farm Bureau, for example, work closely with farmers, often on a personal level.

"It is absolutely crucial to have conservation group interaction," ORSANCO's Youngstrom said. "The fastest way to kill a program is to have environmental regulators on a farmer's property."

In the Ohio River Basin program, state and federal environmental agencies work consistently and closely with point sources on the successful and flexible implementation of their discharge permits. When asked what makes this delicate collaboration tick, Youngstrom said, "Primarily, a very high degree of trust between all interactive parties. Also, a lot of contracts." This trust (and the contracts) takes time and effort to forge. It took hundreds of hours of meetings, webinars, and conference calls to build the necessary communications channels for the Ohio River Basin program—and keeping the channels open is an endless task.

The NEIWPCC Connection

If NEIWPCC came to mind while reading the attributes of an ideal water quality trading broker, there's a good reason: the Commission meets the criteria. NEIWPCC has a strong relationship with EPA and state environmental protection agencies and has supported successful grass-roots community initiatives. As with ORSANCO, NEIWPCC is in the unique position of being structurally designed to facilitate collaboration between states and has a long, successful track record of doing so over the years in the work to achieve higher levels of water quality. In fact, in looking for an effective broker for an interstate trading program, it would be hard to find a better candidate than a well-run interstate commission. Of all the parties involved in the Ohio River Basin program, Youngstrom said it is a natural expectation that ORSANCO will take the reins as broker if and when the program moves beyond the pilot stage.

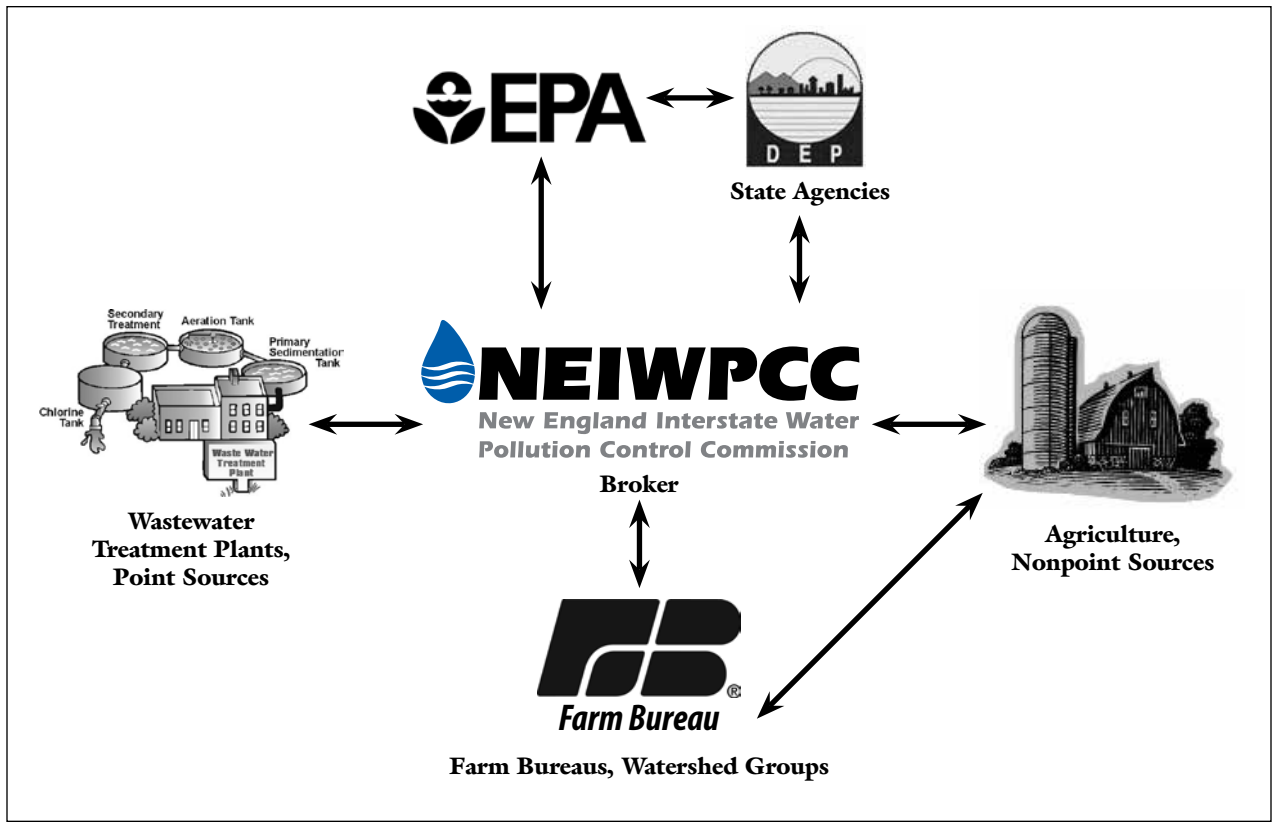
In a future water quality trading scenario in the Northeast, it is not hard to imagine NEIWPCC facilitating between member-state environmental agencies to agree on acceptable trade terms and working with corresponding state university extensions and farm bureaus to encourage farmers to participate. Tradable credits could be stored on a NEIWPCC-managed online database, from which point sources such as wastewater treatment plants could identify and purchase pollutant credits.

Setting up a nonpoint-to-point source water quality trading market is an immense job. The complications are many, the challenges formidable. But despite the obstacles, nonpoint-to-point trading is being embraced by many as a promising new strategy that could bring real, substantial gains in water quality. Will it be embraced in NEIWPCC's member states? And will NEIWPCC play a coordinating role? The answers to those questions are likely a long way off. But one thing is for certain: NEIWPCC is open to the conversation.

* * *

Per Onsager, a senior at UMass Lowell majoring in civil and environmental engineering, drafted this article during an internship at NEIWPCC headquarters in Lowell. Michael Jennings, NEIWPCC's director of water resource protection programs, served as advisor in the development of the article.

Editor's Note: Special thanks to Iliana Raffa, a Connecticut DEEP environmental analyst who works on the state's Nitrogen Credit Exchange program, for reviewing the sections in this article on trade ratios.



Functioning as broker of a nonpoint-to-point source water quality trading market in the Northeast would put NEIWPCC at the center of a network of partners, each with its own needs. With decades of experience in collaborating with multiple parties on complex projects, NEIWPCC is well capable of taking on this challenging role.

Field Day

continued from page 3

Long Island Sound. (Chlorophyll *a* is measured to indicate the level of photosynthetic activity and hence active plant life.) When they arrived at the lab, NEIWPCC Environmental Analyst Inna Golberg, a longtime IEC District staffer, was busy conducting analysis for biochemical oxygen demand, total suspended solids, and fecal coliform on samples of municipal wastewater treatment plant effluent collected earlier in the week.

"The best part of working here is the people," Golberg said. "We have a small staff, but we are very focused and flexible. We work as a team. In fact, we do much more now, with fewer people, than we did years ago when we had double the staff."

Rollizo concurred, then prepared to head home, a good day's work behind her. Though she hoped that next time it might feel a little more like summer out there.

* * *

A NEIWPCC senior manager, Evelyn Powers (epowers@iec-nynjct.org) supervises the IEC District's lab and field operations and coordinates compliance inspections. Please contact her if you have sampling or analytical needs in the New York, New Jersey, and Connecticut region. The IEC District Laboratory is eager to partner with other regional agencies and organizations.

Nymbat Juramt, who accompanied Amanda Rollizo on the July sampling trip, no longer works at the IEC District. He is now a watershed maintainer at the New York City Department of Environmental Protection, and we wish him well.

Pictures of Success

It was quite a gathering in Denver, Colorado, as well over 650 people attended the 24th National Tanks Conference and Expo, September 16-18. NEIWPCC coordinated the event, which brought together the whole spectrum of people in the nation devoted to issues related to underground storage tanks. USTs contain fuel, and when they leak, the impact on surrounding soil and groundwater can be devastating. Attendees included federal, state and tribal representatives; engineers; contractors; and consultants. They attended sessions on everything from biofuels to remediation technologies, went on educational field trips, and frequented the Expo, which featured the latest tanks-related products and services.

We received a lot of positive feedback on the evaluation forms, including: "Excellent conference! Cutting-edge technical information presented that will help me better evaluate and more cost-effectively clean up my LUST sites." And: "This is the single most productive event that we have available. The combination of state and federal staff, owners, and vendors is unbelievable and makes for an awesome learning process for me as a state program manager." As information about the next National Tanks Conference becomes available, it will be posted at http://neiwpcc.org/tanksconference, where you may also download presentations from this year's event. To see the complete set of photos from the 2013 conference, visit our Flickr page at www.flickr.com/photos/neiwpcc/sets/.

The conference begins with a breakfast plenary in a packed ballroom at the Denver Sheraton.

The Expo featured 46 booths displaying tanks programs, services, products, and technologies.

Green on Top

The Benefits of Green Roofs and the Challenge for Acceptance

By Monica Kacprzyk, NEIWPCC

Completed in 2011, the showcase green roof at the Lowell Regional Wastewater Utility measures roughly 6,300 square feet and has dramatically reduced stormwater runoff at the treatment plant.

A roof covered in grass and plants is still a foreign concept to most Americans, but take a look back in the nation's history and you'll find the concept was once familiar. After the Homestead Act was passed by Congress in 1862, any citizen or immigrant could lay claim to acres of land in the prairies for a minor filing fee. The allure of free land and abundant resources attracted settlers from all over the world, but out in the prairies, there was little wood or stone. So settlers made their homes from the main building material that was available: sod—essentially the top layer of earth including its grass, roots, and dirt. Thus was born the old soddie, in which not only the roof but the entire home was made from blocks of sod.

Nobody is saying we need to start building soddies again, but the notion of a roof covered with plants is gaining a following. Green roofs do the opposite of most current infrastructure; instead of draining rainwater away from a building as quickly as possible, green roofs hold water in place for a period of time. The rainwater infiltrates the soil, allowing plants to flourish and providing more time for natural evaporation and transpiration, thus reducing total stormwater runoff volume. With stormwater management a priority in so many urban areas and with heavy rainfall predicted to increase due to climate change, green roofs are sounding like a better idea all the time.

Rewarding Experience

A few miles from NEIWPCC's headquarters in Lowell, Massachusetts, a wastewater treatment plant has proven just how effective green roofs can be. In early 2010, the Lowell Regional Wastewater Utility (LRWWU) was considering various facility upgrades, including green infrastructure such as green roofs, lighting retrofits, solar panels and walls, rain swales and gardens, and pervious asphalt and concrete. Luckily, right around the same time, stimulus money from the federal government became available for green infrastructure upgrades. The utility applied for a grant and received $4.7 million to implement its comprehensive greening plan.

"We wanted to do enough so we could demonstrate that these technologies are applicable to municipal operations," said Mark Young, LRWWU's executive director. "We wanted to provide a showcase where city managers, government officials, and even private contractors could come and view these technologies in a municipal setting."

With the grant money in hand, work began on all components of the utility's plan, including the green roofs. To assist with design, the utility hired two engineering firms, which determined that because of the concrete structure of the buildings at the plant, the load-bearing roofs would not have to be reinforced. The utility decided to build four green roofs with a total area of 14,600 square feet, including one intensive roof—a green roof that's thick enough to support a wide variety of plants—and three extensive roofs, which are lighter and have simpler vegetation. Construction took several months, but in the end, the LRWWU got exactly what it wanted: a large showcase intensive green roof featuring walkways and a thicker soil media (6-8 inches), which supports robust greenery such as lowbush blueberry shrubs, flowering plants, small oak trees, and sweet fern; and three smaller extensive roofs, with less soil media (2-3 inches) and mostly water absorbent grasses.

Over the past two years, the utility has witnessed the benefits, most notably a decrease in the amount of stormwater runoff from the roofs. The hydrologic benefits associated with green roofs tend to be local and are measured by the retention rate—that is, how much water is being retained as opposed to running off a building. While retention rates vary for green roofs due to such factors as soil media and vegetation, researchers have found that in general you get 50 percent or more precipitation retention on a green roof compared to only 10 percent for a conventional roof.

Changing a traditional roof into a green roof also results in an important change to the roof's hydrograph (the rate of flow over a period of time). It makes intuitive sense that with a green roof, the peak discharge flow rate would be less than it would be for an impermeable roof, thus reducing the risk of flash flooding. In an interview with Tom Ballestero, director of the University of New Hampshire Stormwater Center and a NEIWPCC Commissioner, he said that indeed there is a general consensus among researchers of a lower peak discharge rate for green roofs. But he said that when the conversation shifts to water quality issues, there's less agreement.

More retention and less runoff would seem to mean decreased pollutant loads. Even if the water coming off a green roof has the same concentration of pollutants as that running off an impermeable roof, the fact there's less runoff implies pollutant loads would be reduced, correct? Well, yes, but it's not quite that simple. The information is mixed on the water quality of green roof runoff. Some green roofs are effective at filtering out contaminants because the soil used in their construction absorbs heavy metals and nutrients from rainwater. But with so many different types of green roofs and such a broad range of media used, the potential exists for green roofs constructed with certain materials to actually contribute to greater concentrations of some constituents of concern. On the other hand, research has shown that, depending on the soil media used, the runoff from a green roof may be less acidic than the rain that caused the runoff. This pH buffering capacity could last as long as ten years, an important benefit in New England, where acid rain remains a problem.

Benefits and Barriers

The mixed findings on water quality suggest more research still needs to be done on the best media, but about most other aspects of green roofs, there's little dispute. A green roof provides energy savings since it's an excellent insulator, helping to keep a building cooler in summer and warmer in winter. In cities, green roofs help mitigate the heat island effect by shading heat-absorbing roof surfaces and reducing heat gain in a building and its surroundings. In fact, green roofs are better at cooling than retaining warmth, so their insulation benefits are seen most vividly in warmer climates.

Green roofs also provide an important ecological benefit: Once you start planting seedlings and

Mark Young, executive director of the Lowell Regional Wastewater Utility, makes a point to Nancy Stoner, acting assistant administrator for water at EPA headquarters in Washington. Stoner visited the Lowell plant on July 31, 2013, to see firsthand its sustainable solutions to stormwater runoff.

growing an array of grasses, shrubs, and even trees, green roofs can provide a type of island habitat for birds and insects and develop a micro-ecosystem in an otherwise sterile urban landscape. This helps to compensate for green spaces lost to development. There can also be a human dimension. Green roofs provide a natural green space with improved air quality and can include benches for sitting, trails for walking, and even paths for jogging.

Of course, there are challenges too. A roof with plants on it requires more maintenance than one with shingles, but at the Lowell facility, that burden has been manageable. The utility even installed a cistern to capture rainwater for irrigating the roofs, and it's quickly paid off. Since its installation, the cistern has captured about 60,000 gallons of water.

But the biggest challenge is the cost. "We could not have afforded our green roofs if not for the stimulus money," the LRWWU's Young said. "Wastewater equipment upgrades were and still are our priority."

A green roof does cost more to install than a traditional roof, but according to Ballestero, energy savings over the life of a green roof will usually offset the difference in capital cost. It's also important to consider that some green roof benefits, such as a lower carbon footprint and the potential to develop a micro-ecosystem all your own, aren't easily quantified in monetary terms. But those claims often go ignored in a society usually focused on the short-term bottom line. With a green roof costing about $10-30 more per square foot than a traditional roof, there's going to be hesitation—especially if you have 10,000 square feet above your head. There's also the acceptance barrier.

"People know what to expect from conventional infrastructure," Ballestero said. "But green infrastructure is so new that some people just don't want to even go there."

Hesitation also comes from misinformation. One green roof fails and people conclude they all don't work. Or incorrect information is spread by "local experts," who know little about green infrastructure but whose words carry a lot of weight in a community. In reality, most of the technical challenges of green roofs have already been overcome. What makes a green roof successful is straightforward: proper design, construction, and maintenance.

Growth Curve

Environmental groups are pushing EPA to make green infrastructure a priority in a new regulation for curbing stormwater runoff, but even if the new rule boosts the adoption of green roofs, widespread adoption is unlikely without some type of economic incentive. Such an incentive once existed for geothermal systems, in which water is circulated through pipes that extend underground and throughout a building, providing heat in winter and cooling in summer. Ballestero recalled that the geothermal incentive, while it lasted, resulted in an increase in the construction and use of geothermal systems. Green roofs could use a similar lift.

"There's a certain bell curve associated with the adoption of new technologies," Ballestero said, "and we're at the beginning of that bell curve. In the United States, the green roof market is an immature market because it's relatively new. Germany is decades ahead of us, so green roofs cost a third or less of what they cost here."

The economics of green roofs should improve in this country with increased competition and market maturity. Insurance rates should fall once insurers see green roofs are no more prone to damage than a conventional roof. But reluctance on an individual level must still be overcome. Spreading the right information is essential to overcoming homeowners' misconceptions about the complexity of building and maintaining green roofs. It would also help to have more places where people can visit and see the practice in action. A great example of an effective demonstration sight is the Lowell utility, where all that greenery overhead has proven to be a popular attraction.

"When we do our tours and people come to visit our facility," Young said, "they always want to see the green roofs."

* * *

Monica Kacprzyk (mkacprzyk@neiwpcc.org) is a NEIWPCC environmental analyst. She works on a wide range of projects at our Lowell headquarters, providing support to all divisions on multiple programs. This includes assisting with event coordination and writing and providing content for NEIWPCC's website, publications, social media platforms, and other tools of communication.

Standing amid the plantings on the Lowell utility's main green roof, EPA's Nancy Stoner speaks with Jay Pimpare, regional pretreatment coordinator at EPA Region 1 (New England).

First Person

An Inside Look at the Work to Assess Rhode Island's Waters

By Mark Nimiroski, NEIWPCC/RIDEM, and Jane Sawyers, NEIWPCC/RIDEM

Ever wonder how water bodies are really faring after decades of environmental regulation and amid continued stressors such as shoreline development, invasive species, and agricultural runoff? For years, that question has been central to our work as NEIWPCC staff members who work at the Rhode Island Department of Environmental Management's Office of Water Resources on monitoring and assessment. But lately the search for answers has been especially vigorous as the U.S. Environmental Protection Agency works to get a clear picture of the state of the nation's water resources. Working with RIDEM, we're doing all we can to support the effort.

EPA has embarked on a series of national surveys that are examining four types of water bodies—lakes, rivers, wetlands, and coastal areas—across the country. RIDEM, like many other state environmental agencies, is participating in the fieldwork, and that's how we've gotten involved, helping to collect information on water chemistry, biological health, and physical and human disturbance on randomly selected locations in Rhode Island.

So far, we've had to overcome a number of challenges, including a slowly sinking inflatable Zodiac boat. But the occasional frustrations are nothing compared to the satisfaction felt by taking part in such a high-profile effort. We're getting the data—and helping EPA get closer all the time to a valuable snapshot of the nation's waters.

Team Effort

In 2012, we got our first taste of the grueling fieldwork required by this program by participating in the lakes portion of the survey, known formally as the National Lakes Assessment. (The focus of the fieldwork changes among the four types of water bodies from year to year.) We joined with RIDEM staff to get all the training and secure all the necessary equipment, and in June 2012, our crew of six, which also included NEIWPCC's Katie DeGoosh, set out to sample eight lakes located across the state that EPA had randomly targeted. (Random selection means the conditions at the chosen sites can be considered representative of all sites.) We not only endured the sinking Zodiac but also a broken boat trailer. Still, the crew persevered and ultimately we successfully sampled all eight lakes, gathering important local data on lakes that, in some cases, had never been subject to monitoring before.

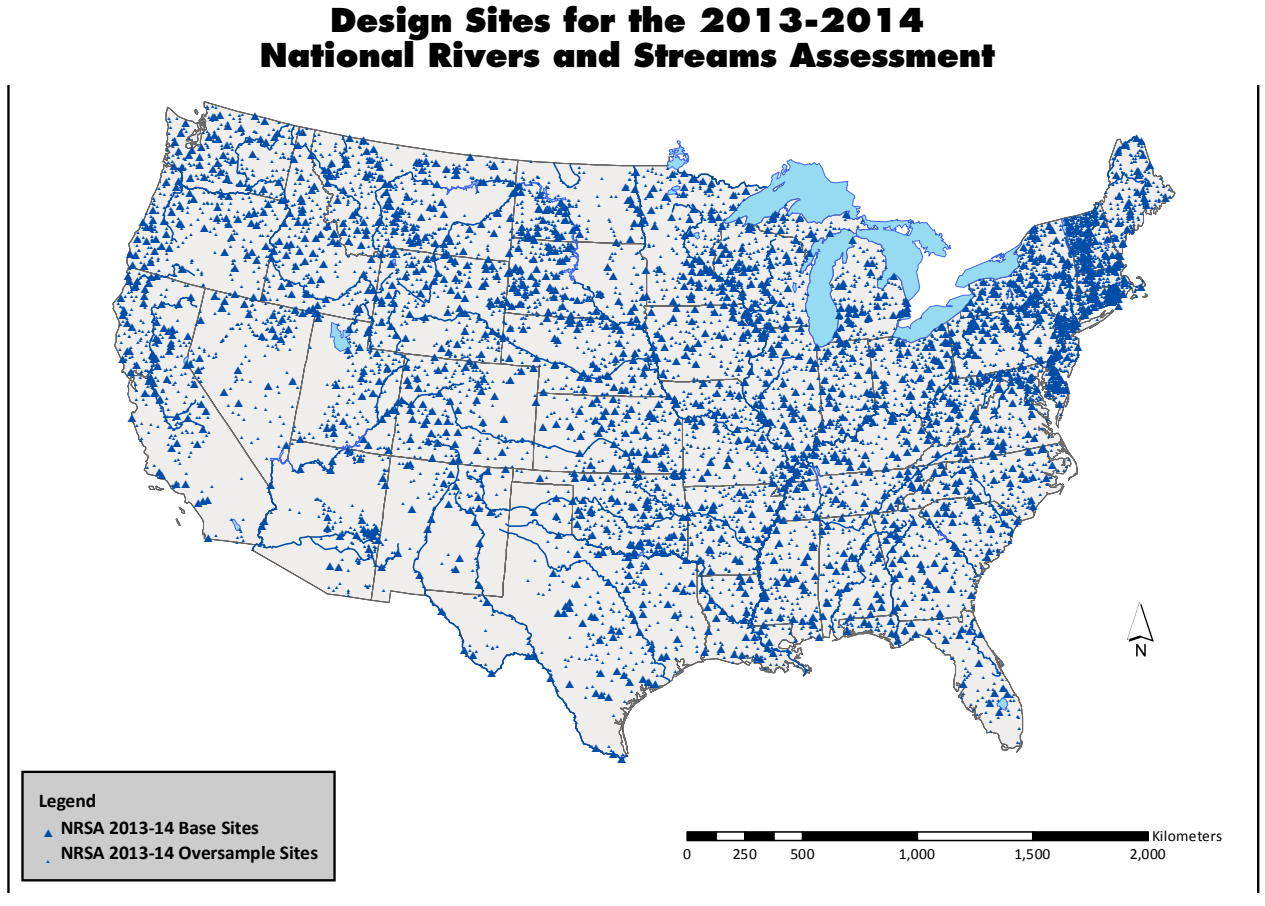
In 2013 and on into 2014, our support to Rhode Island's survey efforts has continued as we coordinate RIDEM's work on the rivers portion, a.k.a. the EPA National Rivers and Streams Assessment. Just how integral NEIWPCC's assistance is to Rhode Island's participation can be seen in the fact that RIDEM didn't take part in EPA's previous river assessments—in 2004 and 2008-9—because there weren't enough qualified state personnel to allow participation. So during those years, the resources EPA made available to states for completing the work went, in Rhode Island, to private contractors instead.

NEIWPCC's Jane Sawyers and RIDEM intern Tyler Bissonnette sample the waters from one of eight Rhode Island lakes targeted in EPA's National Lakes Assessment in 2012.

For the current survey, Rhode Island's draw from the national set of 2,000 randomly selected streams is 14 stations, of which half were targeted this year, with the other half to be done next year. Two of the stations will be visited twice in 2014 for quality assurance and quality control (QA/QC) purposes.

River Work

The process of participating in the river sampling began with an EPA training session in Chelmsford, Massachusetts, June 4-6, 2013, where we received instructions on how to do the work according to EPA's field operations manual. The National Rivers and Streams Assessment is a comprehensive assess-



The 2,000 study sites for the 2013-14 National Rivers and Streams Assessment range across the lower 48 states. The Rhode Island crew is one of more than 50 crews across the country doing the sampling. Biweekly crew conference calls keep all participants up-to date on study design changes and allow EPA to address issues that arise.

ment of streams that covers water chemistry, physical habitat, bug population, and fish population. Work includes water chemistry sampling; surveying of stream slope, width, bankfull height (the point where a stream is just short of overflowing), incised height (the distance a stream has cut down into the underlying bedrock or sediment deposits), and thalweg depth (distance from the lowest point of a channel section to the water surface); measuring the amount of flow; and taking biological samples, including aquatic macroinvertebrates, fish, and algae. Fish are also sampled to analyze mercury and microcystin, an algal toxin, in the fish tissue by removing a small plug from the body.

The need for all that information means plenty of work must be done at each of the 14 stations. Many of the stream measurements are done at 11 individual transects across the stream, with the distance between transects based on the width of the stream; the distance can be as little as 15 meters between transects to as much as 400 meters. This year, a team of five crew members—the two of us plus RIDEM interns Tyler Bissonnette, Chelsea Blatchley, and Elizabeth Futoma—did the bulk of the work at each site over one day and returned the next day for the fish assessments.

In assessing the fish, we are working very closely with Alan Libby, principal fisheries biologist at RIDEM's Division of Fish and Wildlife. Libby is one of the state's top fish experts and author of the recently released RIDEM book, *Inland Fishes of Rhode Island*. By participating in the field work, Libby is not only helping us with fish identification but also adding to his own data. Some of the study sites are a return to previously sampled rivers, so changes in the fish community can be tracked. Other sites are providing a glimpse into areas where the fish community has never been assessed before.

Once we're done in the field, the work isn't over. There are three different laboratories that provide analytical services for this study, and it is vital that the correct samples make it to the correct lab within the holding times to allow analyses to be done before the samples expire. Different preservatives must be added to the samples to keep them from changing before they can be analyzed. Some samples need to be chilled, some do not. Certain samples even need to be frozen and shipped on dry ice, and it is necessary for safety reasons to use special vented trucks to transport dry ice. Given there's only one shipping location in Rhode Island that can ship out dry ice, that's one more hurdle we've had to cross.

Members of the Rhode Island crew stand alongside a target stream discussing streamflow measurement. Note the survey equipment at right.

Teaching Tool

Participation in EPA's national surveys is providing important data to Rhode Island as well as teaching all of us involved about new data collection techniques. By providing assistance to RIDEM, NEIWPCC is providing crucial support that is enabling Rhode Island to contribute to this significant EPA study. The information will go a long way toward helping to keep the waterways of the nation's smallest state healthy and clean for future generations.

While there have been some tough days, the work is rewarding, and we are proud that so far it is going well. As part of EPA's survey process, EPA staff periodically observe field crews in action to ensure proper procedures are being followed and, if necessary, to offer suggestions for improving field techniques. EPA observed our field crew on July 29-30, and we're glad to report we received positive feedback from the reviewers. This is not to say we're perfect. Far from it. In fact, we're learning all the time about better ways to do our work. But it's always nice to get a good grade.

* * *

Mark Nimiroski (mark.nimiroski@dem.ri.gov) and Jane Sawyers (jane.sawyers@dem.ri.gov) are NEIWPCC environmental analysts based at the Rhode Island Department of Environmental Management's headquarters in Providence. Mark assists RIDEM in continuing to develop and implement its ambient water quality monitoring program. This includes conducting work in the field and compiling and managing water quality and related data. Jane is responsible for completing draft nutrient criteria for Rhode Island's freshwater lakes and ponds and for advancing the development of nutrient criteria for the state's rivers and streams, including preparing a river sampling program.

More information on the National Rivers and Streams Assessment is available at http://water.epa.gov/type/rsl/monitoring/riverssurvey/. Details on the National Lakes Assessment can be found at http://water.epa.gov/type/lakes/lakessurvey_index.cfm.

At left: *During a visit to Rhode Island's West River to collect fish community data, Alan Libby (left) of RIDEM's Department of Fish and Wildlife and NEIWPCC's Mark Nimiroski employ the technique known as electrofishing. Electricity is used to temporarily stun fish so researchers can easily capture and study the fish before returning them unharmed to the water.* **Above:** *A collection of photos of some of the catch during the river assessments. Clockwise from lower left: a bucket of fish caught during electrofishing, pumpkinseed sunfish, American eel, juvenile brook trout.*

Formidable List

AWWA Survey Reveals Water Industry Challenges

By Nick Cohen, NEIWPCC

The American Water Works Association, a nonprofit scientific and educational association dedicated to managing and treating water, recently released its annual *State of the Water Industry* report—and as always, it's informative and revealing. AWWA bases the report on responses to a survey it sends to water industry professionals, including utility staff, industry consultants, government officials, and manufacturers. In the report, AWWA highlights the top industry challenges identified by survey respondents. Here's this year's list:

1. State of water and wastewater infrastructure
2. Lack of public understanding of the value of water
3. Capital costs and availability
4. Water supply and scarcity
5. Aging workforce/talent attraction and retention
6. Drought
7. Customer, constituent, and community relationships
8. Cost recovery
9. Regulation and government oversight
10. Emergency preparedness
11. Energy demand/use/costs
12. Climate risk and resiliency
13. Security

What does it all mean in relation to our region and NEIWPCC? First of all, it's not surprising to see the state of water and wastewater infrastructure atop the list. EPA recently released its *Drinking Water Infrastructure Needs Survey and Assessment,* which showed the nation needs $384 billion in water infrastructure improvements. In the Northeast, the situation is acute given so much of our water-related infrastructure is old and in need of repair or replacement. Important steps are being taken; the Boston Water and Sewer Commission, for example, has invested heavily in a three-year capital improvement plan. But overall, much more work needs to be done to fully address issues related to the labyrinth of old pipes and pumps and plants in our region's aging cities.

That brings us to the third challenge: capital costs and availability. Our member states have been closely following developments in Congress related to the potential enactment of a pilot Water Infrastructure Finance and Innovation Authority. WIFIA would be an additional funding mechanism for water and wastewater infrastructure projects, and some organizations strongly back the idea. AWWA has released a document supporting WIFIA as a needed new funding approach for drinking water and wastewater infrastructure projects, especially large projects. On the other hand, several states have raised concerns that WIFIA might take funding away from the critical Clean Water and Drinking Water State Revolving Funds (SRFs). In August, members of the State/EPA SRF Workgroup sent a letter to Congress saying that rather than invent a new program like WIFIA, more federal funds should go to the SRFs.

At NEIWPCC we're very aware of the second challenge—lack of public understanding of the value of water—and its connection to the seventh, the need to improve customer, constituent, and community relationships. To improve delivery of crucial drinking water information, EPA this year allowed, for the first time, drinking water utilities to submit Consumer Confidence Reports (CCRs) electronically. Several of our member states have developed programs to coordinate this electronic delivery option. Our member states are also developing innovative approaches to outreach on water. This spring, NEIWPCC participated in the New Hampshire Children's Water Festival, hosted by the N.H. Department of Environmental Services and others. The festival included hands-on activities and a science fair, and helped build water awareness among youth, a crucial step for progress. This summer, NEIWPCC also once again coordinated the Youth and the Environment Program in Lowell, Massachusetts.

Water supply and scarcity (challenge four) and drought (challenge six) are related concerns, not just in the United States but worldwide. Drought may not seem like a big problem for our region, given we haven't experienced prolonged droughts as in other parts of the country. But the recently released draft *National Climate Assessment* from the U.S. Global Change Research Program indicates that the Northeast will likely face increased periods of intense precipitation *and* increased periods of drought due to climate change. To comprehensively address water supply issues, the Massachusetts Department of Environmental Protection has begun the Sustainable Water Management Initiative (SWMI), which provides a new innovative methodology and process for defining safe yield and stream flow criteria in terms of both ecological and drinking water needs. SWMI should provide MassDEP with a robust framework to guide decisions about water withdrawals and other water management issues.

At number five is a challenge that's emerged as a true priority in our region—an aging workforce and the need to attract and retain talent. With NEIWPCC's help, many of our member states are coordinating management training programs to prepare operators to fill vacancies created by retiring water and wastewater plant managers. And through our regional training program, we offer courses that teach the fundamentals of wastewater plant operation to those entering the field. Organizations such as the New England Water Environment Association and the New England Water Works Association, a section of AWWA, are also working hard to get young, talented people to pursue careers in water and wastewater.

Number nine on the list—regulation and government oversight—is an ongoing issue that becomes more challenging as testing standards and regulations become more stringent. In the drinking water realm, our member states are actively tackling new regulatory requirements, including those enacted by the recent Revised Total Coliform Rule (RTCR), Long Term 2 Enhanced Surface Treatment Water Rule (LT2), and Reduction of Lead in Drinking Water Act. In the wastewater world, concerns continue about changes to treatment plant discharge regulations to address such issues as nutrient over-enrichment in receiving waters. NEIWPCC has long

Boston Water & Sewer Commission

Respondents to the AWWA survey put the state of the nation's water and wastewater infrastructure as the industry's number one challenge. The problem is most severe in the older cities of the Northeast, where portions of systems built more than 100 years ago can still be in use. This image is from a series of historical photos provided to NEIWPCC by the Boston Water and Sewer Commission and available for viewing at www.flickr.com/neiwpcc.

assisted our states on regulatory matters, as evidenced by our current project to evaluate low-cost process modifications and biological nitrogen removal retrofits at select wastewater treatment plants.

Challenges 10 through 12 all relate to climate change. Several major studies, including the *National Climate Assessment*, show that the Northeast has already experienced an increase in heavy precipitation frequency and intensity over the last several decades. In particular, recent storms, such as Irene, Lee, and Sandy, have greatly impacted drinking water and wastewater facilities. This June, NEIWPCC hosted a storm response workshop for our member states to share lessons learned about emergency preparedness, storm resilience, and climate change adaptation. Speakers included representatives from New York City's Department of Environmental Protection, who highlighted work being done under the city's Special Initiative for Rebuilding and Resiliency (SIRR). Many of our member states have begun to address climate change under this "all hazards" approach, integrating climate change adaptation as an emergency preparedness challenge across various sectors. It's also encouraging to see that many utilities in the region have found great benefits from using renewable energy to reduce greenhouse gas emissions, save money, and build resiliency to power outages. Along those lines, Massachusetts deserves recognition for developing a unique review process to ensure drinking water quality is protected when wind and solar energy projects are installed in drinking water source areas.

As for challenge 13, security, it's related to many of the concerns above it on the list, from failing infrastructure to emergency preparedness. With diverse threats to the water sector, security is critically important, and if you haven't visited the website of the Congressionally-authorized Water Information Sharing and Analysis Center (WaterISAC), we encourage you to do so. Located at www.waterisac.org, it's a tremendous resource for information on water security issues, such as cyber-security, extreme weather events, and climate change.

Vermont Department of Environmental Conservation's Mike Kline speaks during a workshop on storm response held this summer at NEIWPCC headquarters. Elements of climate risk and resiliency, the twelfth challenge on the AWWA list, were discussed at the session, which attracted top officials and staff from all seven of NEIWPCC's member states. At left is Pete LaFlamme, director of Vermont DEC's Watershed Management Division and NEIWPCC's chair in 2012 and 2013.

The complete *2013 State of the Water Industry* report and an executive summary are available for free online at www.awwa.org. Non-AWWA members are required to complete a short registration form before downloading.

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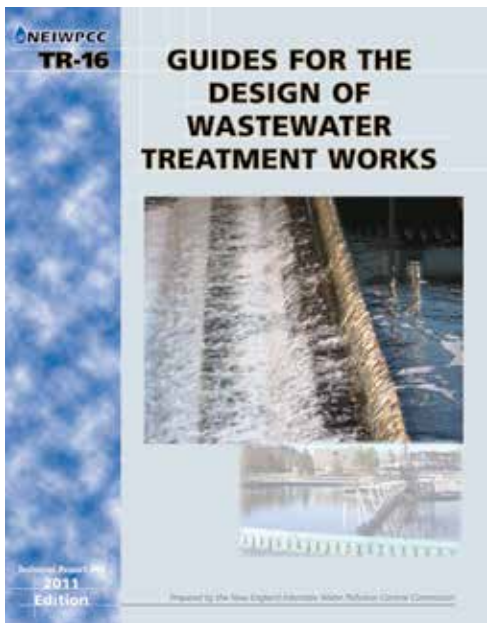
Nick Cohen (ncohen@neiwpcc.org) is a NEIWPCC environmental analyst. He serves as project manager for the Commission's efforts related to climate change adaptation, stormwater, nonpoint source pollution, drinking water, and groundwater/source water protection.

Ready for the Storm

The damaging storms that have struck the Northeast in recent years have made it abundantly clear that wastewater treatment plants must be fully prepared for extreme weather. The need for readiness is especially vital given climate change not only is expected to result in more intense and more frequent heavy storms but has already had such effects as sea level rise, which heightens the threat posed by rising waters. To help WWTPs prepare, NEIWPCC is developing a supplement to our 2011 edition of TR-16 *Guides for the Design of Wastewater Treatment Works*. The supplement will provide guidance on climate change adaptation and storm resiliency that goes beyond what is already included in TR-16.

NEIWPCC's John Murphy and Nick Cohen are leading the supplement's development, which is now officially underway. An advisory committee of federal and state staff has been formed, and the process of identifying plants for case studies has begun. Selected plants will be visited and the lessons learned from the plants' experiences will be a key feature of the guidance. The supplement will include information for Northeast WWTPs that specifies essential preliminary actions, pre-storm preparations, immediate post-storm steps, and actions to be taken well after the storm has passed to evaluate and improve preparation and response. The project also calls for the development of a companion website that will be kept up-to-date with the latest information on resiliency and adaptation.

The supplement is expected to be completed by the end of 2014. In the meantime, demand remains strong for the 2011 TR-16, which is available in hard copy and on CD. To order a copy, visit www.neiwpcc.org/tr16guides.asp.



Warwick (R.I.) Sewer Authority

Weather-related emergencies at wastewater treatment plants, such as the flooding that engulfed the Warwick, Rhode Island, facility in 2010, have spawned the need for detailed guidance on climate change adaptation and storm resiliency.

Protection Plan

Keeping Massachusetts Groundwater Clean is Ultimate Goal of Title 5 Work

By Monica Kacprzyk, NEIWPCC

Students analyze soil at a site in Spencer, Massachusetts, during a NEIWPCC Title 5 Soil Evaluator field session earlier this year. Three field sessions are included in each SE certification course.

Unless you've always lived in a city, most likely you are familiar with septic systems and may even have one in your backyard. What you may not know is that NEIWPCC plays a major role in Massachusetts in helping to prevent those systems from failing and contaminating groundwater. In Massachusetts, regulations pertaining to septic (or onsite) systems are found in Title 5 of the state's environmental code. The section has precise requirements for Soil Evaluators (SEs), who determine whether soil at a site is appropriate for an onsite installation, and System Inspectors (SIs), who conduct the septic system inspections required in Massachusetts in certain situations, such as when property is sold or transferred. In 2004, budget cuts at the state level prompted Massachusetts to shift responsibility for training and certifying SEs and SIs to NEIWPCC, and we've been doing this often challenging but always satisfying job ever since.

Massachusetts contracted with NEIWPCC to run the program in large part because of our extensive training experience. NEIWPCC has conducted regional wastewater training since 1969, and the lessons learned over the years have helped to guide our approach to the Title 5 work. NEIWPCC offers Title 5 training courses that prepare students for SE and SI certification as well as courses that refresh and update the skills of SEs. The SE certification course is held once a year in late spring and consists of both classroom instruction and field work with an emphasis on the principles of soil morphology—that is, the analysis of the different horizontal layers of soil encountered as you dig down into a site. For that reason, NEIWPCC varies the location of the three field sessions in each course so students are exposed to various soil types and geologic features. NEIWPCC holds at least two SI certification courses per year, typically in the spring and fall. While the SI course is conducted entirely in a classroom, the location often shifts to help make the course accessible, no matter where students live. Both the SE and SI certification courses conclude with exams that, if passed, give a student the right to work as a Title 5-certified SE or SI in Massachusetts.

During a NEIWPCC Title 5 Soil Evaluator refresher class in Bridgewater, Massachusetts, students listen as lead instructor Peter Fletcher explains how to evaluate soil profiles and groundwater tables. Fletcher (inset) is a certified professional soil scientist with nearly 40 years of field experience, including more than 25 years with the USDA Natural Resources Conservation Service.

That certification, however, has a time limit: three years. A fee and completed renewal form are all that's required to renew a certification the first time, but subsequent renewals also require proof of 10 hours of training (preapproved for Title 5 renewal)—a requirement that helps immensely in ensuring SEs and SIs remain properly trained and up-to-date on the latest developments in the field. So, for example, if you were certified in 2011, you'd just pay a fee to renew in 2014. But for the second renewal in 2017 and all subsequent renewals, you'd have to show evidence of having obtained at least 10 training contact hours (TCHs) in the time since the last renewal. NEIWPCC's SE two-day, half-classroom/half-field session refresher courses, typically held once or twice a year, provide SEs with a convenient way of satisfying the 10-hour TCH requirement, although approved training sessions from other providers are acceptable as well.

One hallmark of NEIWPCC's Title 5 training sessions is the high quality of instruction. Most of the Title 5 instructors are Massachusetts Department of Environmental Protection staff who deal with septic system regulations on a daily basis and have many years of experience. Our list of regular instructors also includes Peter Fletcher, a certified professional soil scientist who is nationally recognized for his soil

science expertise. This emphasis on securing superior educators is a key aspect of NEIWPCC's overall commitment to providing Title 5 training that is effective and affordable.

"It's very rewarding knowing that we have helped train professionals in a comprehensive and practical manner," said NEIWPCC's Paul Spina, who manages our Title 5 work as well as NEIWPCC's coordination of Massachusetts's wastewater operator certification and training program. "Seeing the satisfaction in the faces of students after a Title 5 field session or after an accomplishment in class is quite rewarding as well."

One of the challenges of coordinating the Title 5 program is the fact that all certifications approved before 2005 renew in the same year. The result is that every three years NEIWPCC processes about 85 percent of all renewals—and 2013 is one of those years. By the end of the year, Spina and NEIWPCC's Michelle Jenkins will have processed about 2,800 SI and SE renewals. It can be taxing work, especially when differences of opinion arise. "Although not all SEs and SIs completely agree with the need for certification renewal and continued training, the program serves an important purpose to ensure that the most qualified people are doing the Title 5 work," Spina said. "With regard to renewals and the Title 5 program as a whole, we always keep in mind that we are dealing with the livelihoods of people and that this may be their primary profession. All SEs and SIs are treated fairly and with professional respect."

The extensive Title 5 training and certification program helps to professionalize the entire onsite industry in Massachusetts. Transparency and quality control are also improved, since NEIWPCC maintains an up-to-date list of approved SEs and SIs, a valuable resource for local boards of health. The list is accessed through NEIWPCC's Title 5 web page (www.neiwpcc.org/training/title5.asp), where we also post renewal information, a schedule of certification classes, a list of approved TCH courses, answers to frequently asked questions, and all relevant forms.

It's all a big responsibility and it's one that NEIWPCC is honored to have—and takes very seriously. As EPA stated in its 1997 report to Congress, "…adequately managed decentralized wastewater systems [such as septic systems] are a cost-effective and long-term option for meeting public health and water quality goals, particularly in less densely populated areas." But the systems must be property installed, operated, and maintained. In Massachusetts, NEIWPCC's Title 5 work is one of the keys to making that happen.

* * *

In the Spotlight

We're excited to announce the hiring of three individuals whose positions represent new directions for the Commission:

Tom Borden is now a NEIWPCC program director with responsibility for overseeing the Narragansett Bay Estuary Program. At the NBEP, he manages all operations and is leading the development and implementation of initiatives and partnerships related to such matters as water quality, stormwater mitigation, habitat protection, and climate change. Borden has extensive managerial and legal experience and served for many years as an attorney specializing in environmental and land use law.

The appointment of Borden is one of NEIWPCC's first moves since being named the new host of the NBEP, which works to protect and preserve the bay and its watershed through partnerships that conserve and restore natural resources, enhance water quality, and promote community involvement. The NBEP is part of the National Estuary Program, a national network of 28 programs working for collaborative solutions for estuaries designated by Congress as of critical importance.

In a press release announcing the appointment, Curt Spalding, regional administrator of EPA's New England office, said, "EPA is happy to welcome Mr. Borden as the new program director of the Narragansett Bay Estuary Program. We look forward to working with him and the management committee to focus on critical new challenges while building on previous successes. Tom will also help us raise public awareness about the importance of this bi-state [Rhode Island and Massachusetts] ecosystem and with his leadership he will help the program improve environmental conditions and water quality in Narragansett Bay."

With NEIWPCC now hosting the Interstate Environmental Commission District, **Bill Shadel** has joined our staff as a NEIWPCC associate director with responsibility for overseeing the IEC District's operations. This includes facilitating discussions between the states of New York, New Jersey, and Connecticut on matters pertaining to the IEC's work. Shadel is well prepared for the job: He has more than 20 years of experience in science education; scientific research; environmental advocacy; and natural resource assessment, management, and restoration from his years at the American Littoral Society, U.S. Army Corps of Engineers, Save the Sound, and other organizations.

The IEC District has been in existence since 1936, helping New York, New Jersey, and Connecticut on a wide range of air and water pollution matters. See the article on page 3 of this issue for a close look at its important fieldwork and laboratory operations.

Aimee Clinkhammer is a new NEIWPCC environmental analyst with a clearly defined focus: coordinating efforts to reduce the pollution in Onondaga Lake. Located in central New York, Onondaga Lake has long been considered sacred by Native Americans, which makes its plight as one of America's most polluted lakes an especially sensitive issue. Major initiatives are underway to clean up the lake, and it is Clinkhammer's job to work on restoration efforts in coordination with the Onondaga Lake Partnership, Onondaga Nation, and other key stakeholders. She is helping to develop a shared community vision for the restoration of the Onondaga Lake watershed and its physical, chemical, and biological integrity, and is working to identify concrete measures that can be taken to achieve that vision.

"We've had a lot of different groups that have come up with a lot of interesting ideas, but there hasn't been one person to help coordinate the ideas along with various levels of government," U.S. Rep. Dan Maffei (D-N.Y.) said in an article on syracuse.com. "What Aimee is going to be able to do is connect some of the dots."

Other new hires since the April issue of *IWR* are **Monica Kacprzyk**, NEIWPCC environmental analyst, Wastewater and Onsite Systems Division; **Gavin Lemley**, NEIWPCC environmental analyst, Hudson River Environmental Conditions Observing System; **Stephanie Oleksyk**, NEIWPCC environmental analyst, Water Quality Division; and **Victoria O'Neill**, NEIWPCC environmental analyst, Long Island Sound Study habitat restoration. Welcome aboard, all!

Monica Kacprzyk

Gavin Lemley

Stephanie Oleksyk

Victoria O'Neill

Congratulations to **Susy King**, NEIWPCC's director of water quality programs, who received a Young Professionals Award from the Association of Clean Water Administrators at ACWA's annual meeting in Santa Fe, New Mexico, August 4-7. The Young Professionals Award honors ACWA members for notable contributions to the work of an ACWA committee, task force, or workgroup and for demonstrated potential for future leadership in ACWA. King has participated for years in several ACWA groups, including the Legal Affairs Committee; Monitoring, Standards, and Assessment Committee; and the

TMDLs and Watersheds Committee. She also represents ACWA on the Environmental Council of the States' Quicksilver Caucus.

"It is such an honor to receive this award from ACWA," King said. "One of the greatest benefits of being a younger member of the association is learning from colleagues with tremendous expertise in the water quality field gained from many years of experience. Having these connections has helped me so much in my work with the Commission and provided me with a great resource of knowledge."

Susy King in Santa Fe

This is just the latest major award for King, who in 2009 received an Environmental Merit Award from EPA for her work in developing the Northeast Regional Mercury Total Maximum Daily Load. King's partner on the TMDL, **Bethany Card** (right)—NEIWPCC's then-director of water quality programs—also received an EPA Environmental Merit Award for her work on the project, and coincidentally, Card also got a major award from ACWA in Santa Fe. Card received the President's Service Award, given to ACWA members for exceptional service to the association over the last fiscal year. Card is now an assistant commissioner at the Massachusetts Department of Environmental Protection, overseeing its Bureau of Resource Protection. She represents MassDEP Commissioner Kenneth Kimmell at NEIWPCC Executive Committee and Commission meetings.

In its awards ceremony, ACWA honored one other individual with a strong NEIWPCC connection. **Harry Stewart**, director of the New Hampshire Department of Environmental Services' Water Division, received the Environmental Statesman Award, ACWA's highest honor. The award is presented to ACWA members who have demonstrated outstanding service to the association over many years. Stewart has served in multiple leadership roles at ACWA, including president. At NEIWPCC, he's been a leader too, serving as our chair in 2006 and 2007. Stewart has represented the commissioner of NHDES at NEIWPCC Executive Committee and Commission meetings since 1998.

Every quarter, NEIWPCC presents our Above and Beyond Recognition Award to a worthy member of our staff, and the two latest recipients are **Michele Piazza** and **Spring Connolly**. Michele works at our Lowell headquarters as NEIWPCC's office manager/meetings and events. In her nomination of Michele, NEIWPCC Environmental Analyst Heather Radcliffe wrote, "Michele thrives on helping others succeed. She welcomed me to NEIWPCC wholeheartedly and always makes me feel a part of the team… I'd be lost without her positive and committed guidance."

Michele Piazza

Spring Connolly is a NEIWPCC administrative assistant at the South Portland offices of Maine's Joint Environmental Training Coordinating Committee. In her nomination of Spring, NEIWPCC Information Officer and JETCC Coordinator Leeann Hanson wrote, "This was an especially hectic quarter for the JETCC office, particularly toward the end of the month with the North Country Convention… Spring plowed through it all with a calm demeanor and a "can do it" attitude… Throughout times of intense activity, Spring maintains focus, systematically completes every task, and frequently finds a more efficient way to accomplish what she is asked to do." Congratulations to you both, and thank you for your hard work and dedication.

Spring Connolly

While he may not work in our region, **Curt Johnson** of Alabama's Department of Environmental Management is certainly deserving of mention here for the incredible work he's done related to underground storage tanks. At the National Tanks Conference and Expo in September in Denver (see page 10), Carolyn Hoskinson, director of EPA's Office of Underground Storage Tanks, presented Johnson with an award acknowledging his 20 years as chair of the National Work Group on Leak Detection Evaluations. The NWGLDE is an independent workgroup made up of 11 state and federal UST regulators; they work together on reviewing leak detection system evaluations to ensure the systems meet EPA or other regulatory performance standards. (Learn more at www.nwglde.org) It's vitally important work and Johnson has overseen it all for two decades. We join in saluting him for a job well done.

Johnson with EPA's Carolyn Hoskinson

Follow NEIWPCC on Social Media

If you're already a Twitter user, follow us by visiting twitter.com/neiwpcc. If you're new to Twitter, get started by creating a free account at www.twitter.com. Then type twitter.com/neiwpcc into your browser's address bar, and once on our Twitter page, click "follow" in the upper right. We think you'll be glad you did!

If you have a Facebook account, we'd appreciate a "like," which allows us to send you messages and will help spread the word about our page to your connections. If you don't have an account, create one for free at www.facebook.com. You don't need a Facebook account to view our Facebook page or anybody else's, but an account will allow you to make connections with other Facebook users—and we'd like to connect with you!

We're now making all of our favorite photos even more accessible by posting them on Flickr, the popular photo management and sharing application. Visit www.flickr.com/photos/neiwpcc/sets/ to see photographs of NEIWPCC events, including nearly 50 pictures taken at the recent National Tanks Conference and Expo in Denver. Our Flickr page also includes more than 150 fascinating historical photos provided to us by NEIWPCC Commissioner John Sullivan, chief engineer at the Boston Water and Sewer Commission.

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Graduation Day

The weather was beautiful and the setting magnificent as 17 environmental professionals gathered in Sugarloaf, Maine, on September 19 to receive diplomas for completing the state's Management Candidate School. The year-long program educates mid-level drinking water and wastewater treatment plant personnel in what it takes to be an effective plant manager. The curriculum includes monthly sessions on such topics as supervisory skills, labor relations, and budgeting. The program, which began in 2010, is coordinated by NEIWPCC's training arm in Maine, the Joint Environmental Training Coordinating Committee (JETCC). Support is provided by the Maine Department of Environmental Protection, Maine Department of Health and Human Services, Maine Wastewater Control Association, and Maine Water Utilities Association. NEIWPCC has helped many of our member states in developing and conducting such programs, which have succeeded in mitigating a problem that not long ago loomed large in our region: too many plant managers retiring and too few individuals prepared to replace them.

This year's graduation ceremony in Maine took place during the Maine Wastewater Control Association's annual convention in Sugarloaf. Front row (left to right): Benjamin LaPlante, Kennebec Water District; Keefe Cyr, Bangor Wastewater Treatment Facility; Peter Godfrey, Greater Augusta Utility District; Marissa Carr, Maine Water Company-Biddeford & Saco; Chelsea Elliot, Alfred Water District; Eric Altvater, Machias Wastewater Treatment Plant. Back row (l-to-r): Tom Wiley, South Portland Water Resource Protection; Andrew Whitaker, Saco Water Resource Recovery Facility; Jeffrey Moulton, South Portland Water Resource Protection; Tom Mason, Brunswick Sewer District; Alex Buechner, Biddeford Wastewater Treatment Facility; Michael Cummons, Maine Water Company-Rockport; Stanley Doughty Jr., Brunswick & Topsham Water District; Justin Futia, City of Portland; Jeffrey Hatch, Greater Augusta Utility District; Andy Bryant, Ted Berry Company; Chris Curtis, Yarmouth Water District. *Not pictured:* Chris Remick, Maine Water Company-Bucksport.