Bucknell River Reporter

A QUARTERLY NEWSLETTER BY THE SUSQUEHANNA RIVER INITIATIVE

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An engineer's perspective of our local streams and rivers

By Jessica T. Newlin, Ph.D., P.E.
Department of Civil and Environmental Engineering

Diving Deeper

Our built environment often intersects with and puts additional pressure on the natural environment of our streams and rivers. While catastrophic events such as Hurricane Irene and Tropical Storm Lee in the fall of 2011 often thrust the conflict between the built environment and the natural environment into the limelight, these systems are constantly interacting with each other.

The built environment provides many amenities for our society: bridge crossings to enhance connection, levees for property protection, and reservoirs for drinking water or irrigation water supply, to name a few. As with many of our actions, time has revealed unintended consequences of the initial design of our infrastructure. Many of these consequences are a result of the built environment infringing upon the natural environment of our streams and rivers. Streams and rivers are dynamic systems that require space and continuity in order to properly function. Our built environment often restricts the ability of a stream or river system to be resilient to natural and human-induced changes in the flow and/or sediment loads to these systems. While floods often catastrophically demonstrate

(cont'd pg. 2)

Figure 1. Collecting river data downstream of a bridge crossing on Loyalsock Creek as part of the Bucknell River Mechanics class;: Brian Charland '13, Akmal Daniyarov '12, Emily Guillen '13, Bill Prendeville '13, Emily Liggett '12, and Matt Spagnoli '12. [Photo: Jessica Newlin - March, 2012]

The river: No news = Good news (?)

The Susquehanna kept flowing along this summer and fall without any major floods, droughts, or chemical spills, for which we are very thankful. And from the public's perspective, the Adam T. Bower "fabridam" did its job — the weather generally cooperated and a good summer was had by many recreationists. Fishing was, as always, good, bad or indifferent depending on the day, the desired species, the weather, and one's skill and/or luck, or lack thereof.

But that does not belie the reality that much is happening on the river! In this issue, we are delighted to feature a *Diving Deeper* article by civil engineer Dr. Jessica Newlin on human-induced impacts on our rivers; a look at student efforts to assess what various municipalities are doing to prepare for the next emergency (flood); a summary of the types of dams in the watershed; an editorial on science and the state of the river; and a summary of river flows for the past several months.

You might have noticed the river was quite low in September and that rocks and channel features were visible in the barely-discernible flow. I suspect there may have been at least one newspaper article about wading and even bicycling across the river!

We look forward to seeing you at our 8th Annual Susquehanna River Symposium on October 18th and 19th … it'll be a wonderful event!

Dr. Fred Swader
Editor

SUSQUEHANNA RIVER INITIATIVE

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An engineer's perspective of our local streams and rivers *(continued)*

this, the fragmentation in our natural streams and rivers affects the everyday functioning of these systems. The presence of dams in these systems is an obvious barrier to continuity. Levees often disconnect a stream or river channel from its floodplain; and even bridges and culverts affect the continuity of the channel processes that support the natural environment.

Pennsylvania has over 6,400 bridges in the Susquehanna River watershed that are listed in the National Bridge Inventory. This does not include smaller bridges (less than 20 ft in length) or countless culverts that convey water under our roadways. There are nearly 100 major dams (greater than 50 ft in height or storage capacity greater than 5000 ac-ft and over 130 smaller run-of-the-river dams in the Susquehanna River watershed within Pennsylvania. This is a considerable amount of fragmentation, and our built environment is testing the resiliency of the natural stream and river systems in our area!

What can be done?

Through interdisciplinary collaborations with the Susquehanna River Initiative, I have been investigating small stream and large river systems in the Susquehanna River watershed. It has been an area of interest for student research, and engineering students have been examining these dynamic stream and river systems in classroom work (Figure 1).

We have spent considerable time investigating the sediment transport dynamics at low bridge crossings in the Susquehanna River watershed. One site in particular is White Deer Creek, shown in Figure 2. A stream restoration project has been installed at this location in order to mitigate some of the prior sediment and habitat issues observed at the site. It is not unusual for the low bridges over small streams to have at least partially blocked waterways (see Figure 3). It is apparent that the continuity of the stream system is lost in this case. Not only is the natural environment impaired, but the infrastructure is no longer safely functioning as it was originally designed.

By monitoring the White Deer Creek site over a 3-year period, Brian Schultz (BSCE '10, MSCE '12) was able to develop mathematical models of the interactions between the built environment (bridge and stream restoration structures) and the natural environment (water flow and movement of sediment). We found that some of the effects of the low bridge crossing are not mitigated by the stream restoration structures. While some habitat function may be restored in a portion of White Deer Creek, the continuity of the stream system has not been completely restored. There is still an apparent discontinuity in sediment dynamics at the bridge crossing that prevents the stream system from functioning as a resilient natural environment.

Looking Ahead

Studies such as the one described at White Deer Creek are important in terms of informing the engineering practice on potential improvements to design guidelines for the built environment. For example, the guidelines for low bridge crossings could be improved to lessen their impact on the stream systems that they are crossing. We also have begun to extend our research on small streams to the larger rivers in the Susquehanna River watershed though the investigation of the formation of channel features in these river systems. Understanding the natural channel dynamics of these larger river systems will serve to inform better management and design practices that can allow the natural environment to function without unnecessary pressures from the built environment.

Figure 2. White Deer Creek stream restoration project, looking upstream at a rock cross vane structure during low flow conditions.
[Photo: Jessica Newlin - September 9, 2010]

Figure 3. A low bridge crossing of State Route 14 over Roaring Branch Creek, a tributary to Lycoming Creek in Bradford County, PA. View is downstream.
[Photos: Jessica Newlin - June 16, 2011]

How Susquehanna river towns deal with flooding

By L. Donald Duke, Ph.D., P.E.
Visiting Professor of Civil and Environmental Engineering, Bucknell University and Professor of Civil Engineering, Florida Gulf Coast University

Two students in Bucknell's department of Civil and Environmental Engineering had an opportunity to conduct hydrologic research on the Susquehanna River during the summer of 2013. Sophomores Ellen Kalnins and Ryan Murphy worked for ten weeks on a policy-oriented study that evaluated the approaches to flood control, management, and response in the Central Susquehanna basin.

I developed the research idea after the 2012 Susquehanna River Symposium focused on flooding of the Susquehanna. The Susquehanna Heartland Coalition for Environmental Studies supported the research with a summer internship grant, and the Civil and Environmental Engineering Department matched the grant to pay for a second intern.

The question was: *What differences, if any, are to be found in the flood-response approaches of the fiercely independent boroughs and townships of our region?*

The answer: *Enormous differences.*

Some are for the better, accommodating varying townscapes and watersheds; but others create barriers to integrated approaches that might be useful in a region connected by a single river and its many tributary creeks. The research selected a dozen towns in a tightly-focused area for intensive study and comparison, from Lock Haven on the West Branch and Bloomsburg on the North, downstream to Selinsgrove.

Ryan and Ellen delved into library and Internet sources, ranging from local newsletters through state reports and federal agency studies. In the hands-on tradition of the Susquehanna River Initiative and its research they also visited nearly every town in the study area, interviewing flood control managers; touring pumping facilities and neighborhoods zoned for sparse habitation; and walking along miles of dikes, levees, and concrete floodwalls.

The researchers compiled an understanding of the towns' various approaches and assessed them in the context of U.S. and Pennsylvania flood policies. The research, with its policy orientation, is very different from many of the SRI's research efforts that focus on hydrological, geological, or biological science.

Ellen, Ryan, and I will present our findings in a poster at the eighth annual Susquehanna River Symposium to be held Oct. 18-19 in Bucknell's Elaine Langone Center.

[Photos: L. Donald Duke]

A Fragmented System: Dams in the Susquehanna Watershed

By Dr. Benjamin R. Hayes, Susquehanna River Initiative Director

There are currently over three thousand constructed dams currently in use in Pennsylvania, and most of them are within the Susquehanna River basin. A civil-engineering technology brought here in the 1700s from Germany and the Netherlands by Europeans who colonized the region, tens of thousands of dams have been built for power generation, water supply, flood control, navigation, and recreation. They have local and regional impacts, some positive and some negative.

Many more dams have been proposed than constructed. The result is that the Susquehanna is a fragmented river system, whose streams have not flown freely for three and a half centuries. Many would like to see all of the dams removed to let aquatic life and recreational paddlers move freely along the length of the river. What would be the environmental, economic, and societal impact of doing so? Millions of people and many industries (jobs) depend on them for recreation, water supply, and electricity. The solutions and decisions are complex and will ultimately require trade-offs and social adjustment.

Environmental and societal issues aside, there is a fascinating history of dam construction in the Susquehanna. It is striking to ponder the shear number of dams constructed in the watershed, and staggering amounts of raw materials, energy, and human man-hours spent building, operating, and maintaining these facilities. Dams are now an integral part of the Susquehanna watershed and in some way our lives are affected by them.

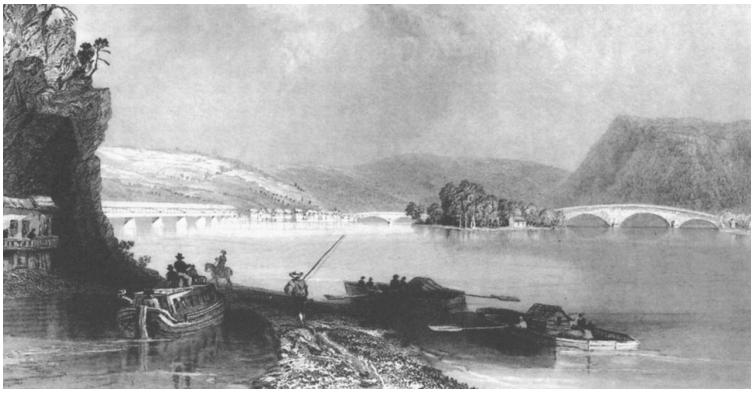
Water-Powered Mill Dams (late 1600s to early 1900s)

The first dams in the Susquehanna were built by private citizens on small streams throughout the watershed to power iron ore mining and furnace operations, grist mills, hammer-forges, and saw mills. Walter and Merritts (2008) document that more than 16,000 mill dams likely existed in the mid-Atlantic region! The dams also served as water supply ponds for livestock , irrigation, tanneries, and for powering belt-driven shafts in clothing mills and factories. The dams and associated pond and mill races completely changed the hydrology and morphology of these streams. Also, as surrounding forested watersheds were converted to farms, roads, and urban areas, sediment yields increased dramatically. The dams were filled to capacity with "legacy sediments," which now pose a difficult restoration problem. Most of these dams are now defunct, deteriorating, and in a state of disrepair. Many are breached during floods, washing tons of sediment down river and ultimately to the Chesapeake Bay.

Canal Feeder Dams (early 1800s to mid-1800s)

Heavy timber cribs filled with rocks were used to build 10 ft high dams across the Susquehanna to divert water to canals dug along the floodplain corridor. Before the railroads and highways were built, the Pennsylvania Canal network was used to transport people, food, materials, and coal from the Chesapeake Bay to New York and western Pennsylvania. Remnants of canal feeder dams can still be found at Lewisburg, Nanticoke, Shamokin Dam, Clark's Ferry, and Wrightsville.

1919 photograph of mill dam on West Branch of Little Conestoga Creek in Lancaster County, PA from PA Department of Protection (PA DEP) Dam Safety inspection files and presented by Walter and Merritts (2008). Efforts are underway to remove or repair these dams to improve geomorphic, environmental, aesthetic and safety conditions and reduce the risk of delivering tons of of legacy sediments to the river and Chesapeake Bay.



1840 drawing by English artist William Henry Bartlett illustrates "Lake Augusta" at the confluences of the North and West Branches of the Susquehanna RIver at Northumberland as viewed from Blue Hill, with a canal boat and river ark in the foreground. A timber and rock dam was used to create a 10-ft deep pool to divert water to the Pennsylvania Canal as well as provide navigation for a steamboat ferry across the river. Local towns now identify themselves with the lake; one borough is even named "Shamokin Dam." In 1874 a group of rowers (log raftmen and shad fishermen) competed in a regatta on this lake. The dam was destroyed in March 1904 following the breakup of 22 inches of ice during a sudden spring thaw. [Image: Northumberland County Historical Society]

The Adam T. Bower dam, built in 1964 at the location of the old Northumberland canal feeder dam shown above. At 2,100 ft long, it is the worlds longest inflatable flexible membrane dam, constructed of laminated sheets of rubber that form a giant tube that is filled with air to create 12 sq. km. Lake Augusta, a popular fishing, boating, and recreational attraction in the central Susquehanna River valley. [Photos: National Oceanic and Atmospheric Administration National Weather Service]

A Fragmented System: Dams in the Susquehanna Watershed *(continued)*

Logging Splash Dams (1840 to 1910)

Hundreds of small, temporary dams were built by logging crews to catch the spring freshets and flush logs out of the headwater streams and down river to the sorting facilities and saw mills. Hayes (2010) estimates that over 600 of these temporary "splash" dams were built in Pennsylvania and New York. Little is know about the impact these dams had on the aquatic life in the river, but the effects of deforestation, channel clearing and straightening, and berm construction associated with log drives are still evident in the watershed today.

Sluicing logs through the gate of the Flooks Run splash dam, built near the confluence of Otter and Little Pine Creeks in Lycoming County, PA. [Photo: Lycoming County Historical Society]

Flood Control Dams (1940s to 1980s)

Since Congress passed the Flood Control Act of 1936, the U.S. Army Corps of Engineers has dammed fourteen of the Susquehanna's tributaries to control the flow of about 12 percent of the headwaters. The idea is to retain runoff in the headwater regions of the watershed and reduce flooding downstream. In the West Branch of the Susquehanna, four flood-control dams have been built: the Alvin R. Bush Dam on Kettle Creek, Curwensville Dam on the West Branch itself, George B. Stevenson Dam on Sinnemahoning River, and Foster H. Sayers Dam on Bald Eagle Creek. The Corps now operates them as a system to reduce the flow of the river at Lock Haven and Williamsport. In the North Branch of the Susquehanna watershed, eight dams regulate tributaries: East Sidney Dam (Ouleout Creek) Rockbottom Dam (Chenango River), Tioga, Hammond/Ives Run, Cowanesque, Almond and Arkport. In the Juniata watershed, one dam forms Raystown Lake, the largest reservoir in Pennsylvania.

Alvin R. Bush flood control dam on Kettle Creek in the West Branch, captures 92% of the runoff in this watershed. It attracts over 10,000 visitors each year, costs $792,000 annually to maintain, and is estimated to have prevented $272 million in downstream flood damages since being built in 1961. [Photo: U.S. Army Corps of Engineers]

Low Head Recreational Dams (1840 to 1970)

Many low-head dams have been built across the Susquehanna River channel to provide year-round recreational pools for boating and swimming. However, they are expensive to maintain and create barriers to fish and other aquatic life. There are competing recreational uses as well, with canoeing and kayaking groups wanting them removed because of portage and safety concerns.

The West Branch includes: Irvin Park Dam (Curwensville, PA), Raftman's Memorial Dam (Clearfield), Grant Street Dam (Lock Haven), Hepburn Street Dam (Williamsport). The North Branch includes: Binghamton Dam, Adam T. Bower Dam (Sunbury), and Dock Street Dam (Harrisburg).

Hepburn Street dam and flood levee wall (foreground) on the West Branch Susquehanna River in Williamsport, PA. [Photo: Ruhrfish]

Dock Street dam in Harrisburg, PA. Only 10 to 12-ft high, it extends 3,460 feet across the Susquehanna and was built in 1913 to provide a deep recreational pool in the otherwise shallow, rocky channel in this section of the river. [Photo: Pennsylvania Fish and Boat Commission

A Fragmented System: Dams in the Susquehanna Watershed *(continued)*

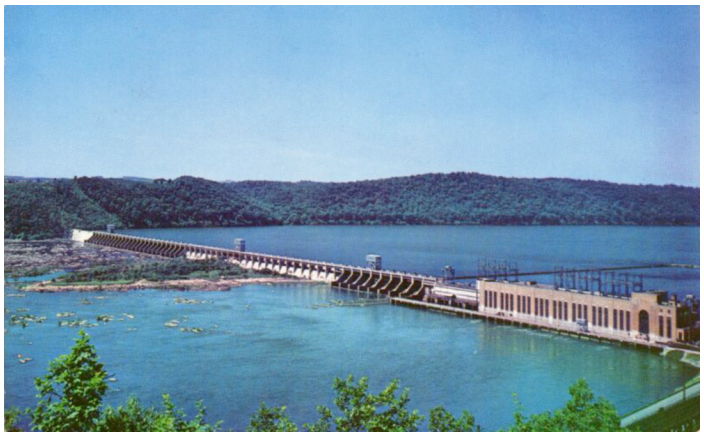
Water Supply Reservoirs (1880 to 1950)

Since the middle of the 19th century, dams have been built to store water for the river and for public drinking water. Aqua America operates a series of water reservoirs the Roaring Creek watershed that for over 130 years have provided potable water to nearby towns whose aquifers were lost to anthracite coal mining. Cowanesque and Curwensville are large modern dams built to store water that could be released to the river during droughts to offset consumptive use. Consumptive users evaporate water, incorporate it into a product, or otherwise do not return it to the river. These users, primarily electric utilities, pay the SRBC an annual fee, which they then pass on to the federal government.

Begun in 1973 and completed in 1980, a 3,100-ft long by 151-ft tall earthen dam was constructed on Cowanesque Creek, a tributary to the Tioga River in Potter County, PA to create 1,090-acre water storage reservoir. The Susquehanna River Basin Commission and the U.S. Army Corps of Engineers built the Cowanesque Reservoir to store water to release to the Susquehanna during extreme low-flow periods. [Photo: U.S. Army Corps of Engineers]

Hydroelectric Dams (1910 to 1950)

The North Branch has the Shawville Dam, the Goodyear Lake Dam (Colliersville, NY) and the Johnson City Dam (Goudy Power Plant), and the Oakland Dam on the North Branch. The lower Susquehanna include York Haven, Safe Harbor Dam, Holtwood Dam, and Conowingo Dam (MD).



Safe Harbor hydroelectric dam on the Susquehanna River.
[Photo: Conestoga Area Historical Society]

Fish passageway at the York Haven hydroelectric dam.
[Photo: Kleinschmidt Engineering]

A Bucknell alumna with a career in watershed management and water pollution biology is now helping with the relicensing of Susquehanna River dams and hydroelectric facilities

Kimberly Long received her master's degree in Biology from Bucknell University in 2002 and is now the Senior Program Manager of Hydropower Relicensing for Exelon Corporation, the owners of Conowingo Hydroelectric Generating Facility on the lower Susquehanna River in Maryland.

Kimberly Long (MS '02) is Sr. Program Manager of Hydropower Relicensing at Exelon Corporation. [Photo: Frank Brill]

Kim is a major contributor to this year's *Susquehanna River Symposium "A Fragmented System - Dams on the Susquehanna River"* and this edition of the *Bucknell River Reporter*. We asked her several questions about the federal hydropower relicensing process and how her experience at Bucknell helped prepare her for this role.

Where does the electricity generated from Conowingo hydropower facility go?

The Conowingo Hydroelectric Generating Facility provides electricity to the PJM grid. From the PJM grid, the electricity is distributed in 13 states to a variety of users including, but not limited to residential homes, commercial buildings and industrial complexes.

Who are stakeholders in the dam?

Stakeholders of Conowingo and the relicensing process include local, state and federal government agencies, recreational (boating, fishing, trail, etc.) groups.

What are the important aspects of dam relicensing? How does the FERC relicensing process work?

Exelon is pursuing relicensing of Conowingo using the Federal Energy Regulatory Commission (FERC) integrated licensing process (ILP). The ILP is a 7 to 9 year process that involves consultation with regulatory agencies and stakeholders throughout the process and establishes milestones to be met by the licensee, FERC and the stakeholders. Generally, in an ILP, the licensee will begin gathering information in support of the formal licensing process a few years before licensing begins.

The formal process begins when a licensee submits a *Pre Application Document* and a *Notice of Intent to File Application* with FERC. From there, licensing involves the development and completion of various environmental studies in consultation with the stakeholders.

In the case of Conowingo, 32 studies were conducted that include aspects such as fish and aquatic resources, fish passage, instream flow and habitat, water quality, sediment introduction and transport, and recreational and shoreline management.

Following the completion of the studies, those results and additional information are submitted to FERC in a *Final License Application* from which point cooperative discussions with the stakeholders regarding resources of interest begin in order to develop prescriptions that are included in the reissued license. Conowingo filed its final license application in August 2012.

How do dam owners/operators partner with environmental regulatory agencies, consultants, and NGOs on sustainable, renewable hydropower?

Through the integrated licensing process (ILP), the Federal Energy Regulatory Commission (FERC) rules provide for public participation in the relicensing process. This process is designed to provide opportunities for interested groups and stakeholders to participate.

Various public meetings, comment/response periods and public filings provide a forum in which the public is encouraged to participate.

Outside of relicensing, Conowingo regularly partners with local groups and organizations in a variety of activities including watershed cleanup events, open houses at Conowingo and other events.

What things about your job are the most interesting?

I am fortunate to fulfill the roles and responsibilities of my current position as a Senior Program Manager of Hydro Relicensing in the Exelon Power Environmental Programs group as I perform a variety of work and tasks that involve aspects such as water quality, biological studies and research, rare/threatened/endangered species considerations and management, and the licensing process.

Due to the variety of work that I conduct on a day-to-day basis, I am also fortunate to work with a variety of people including other Exelon environmental staff, Exelon station personnel including technical and management representatives, government agencies and consultants and technical representatives involved with fisheries, watershed management, water quality monitoring and modeling and environmental law.

Conowingo Dam on the lower Susquehanna River in Maryland.
[Photo: Exelon Corporation]

What points about dams and the Susquehanna would you like the public to know?

The Susquehanna River is a complicated system, especially the Lower River. The river is unique in that it exhibits natural characteristics such as its channel slope from Harrisburg to Havre de Grace that provides a flow regime/gradient that afforded the ability for four hydro power and other power facilities to be constructed within a relatively short river mile distance.

The hydroelectric dams present in the Lower Susquehanna River provide a unique resource to the public and the electric grid as they serve as a flexible power source that can respond to emergencies or losses of power on the grid in a manner of minutes.

In addition, the Susquehanna River is also complex as it receives various point and non-point source inputs throughout its vast 27,500+ square mile watershed.

How did your graduate experience at Bucknell prepare you for your current job?

While studying at Bucknell to pursue my masters degree, I completed various courses such as limnology, vertebrate diversity, plant systematics and statistics that play a crucial role in my professional life today.

Those courses form a backbone of information that I have built upon throughout my professional career and I continue to utilize that information. In addition, working on my graduate thesis at Bucknell provided opportunities for me to improve research, statistic, scientific writing and public presentation skills that have been important to my career no matter what position I may have held.

Science, "safety," and the State of the River

Editorial

By Fred Swader, Ph.D., Faculty Associate

There have been lots of articles about "the river" in the news lately. They all seem to be related to the matter of a "safe" river. A guest editorial in a recent edition of one of our local newspapers suggested the public should demand that science declare the river "safe."

In August, the same newspaper reported the rescue of a young girl at Shikellamy State Park, which illustrates that the river is never "safe" if you are unprepared to swim (or to rescue.) Fortunately, it all turned out well.

A different article about the local bass tournament suggests that a fairly large group of people can use the river "safely" for catching fish.

There probably can be no agreement on what constitutes a "safe" river for any particular species of fish; populations vary with time and other natural (or even unnatural) river conditions. An untimely flood may have a huge impact on the population of a given species. So could a chemical spill.

It is unfortunate that we do not have a long-term and comprehensive database of chemical and physical parameters that characterize the state of the river. We know that abandoned mine drainage has been somewhat lessened, that we no longer have widespread logging in the watershed, and that there are no more "log rafts" on the river, but we have little data on chemicals in the water, their effects, or their real sources.

In our first *River Reporter*, Dr. Craig Kochel posited that we are still seeing the effects of the rapacious timbering of the Northern Tier. In this issue, Dr. Jessica Newlin presents other evidence of the effects of our built environment on stream flows and flooding.

A new YSI EXO multi-parameter water quality sonde getting ready to be deployed on the main stem of the Susquehanna below Sunbury, to compliment our existing sondes at Milton and Danville. As part of our *State of the Susquehanna* longitudinal assessment of the river, SRI faculty and staff have secured the funds to purchase these state-of-the-art instruments and hire students and staff to conduct routine calibration and maintenance needed to ensure good water quality data. They have also written software to retrieve the data from the sonde via cell modem, store them in a relational database, process and filter the data, and display them as time series or tables on a web portal. [Photo: Sean Reese, Bucknell University Environmental Center Susquehanna River Initiative]

We previously reported on the Bucknell water quality sondes in the river, and the website to access the data. It would be good to have more such equipment — all that is needed is the funding to acquire it, to maintain it, to transmit the results to a computer, and to maintain the web site. Mind you, this still does not give us any kind of an historic database for making comparisons.

We are also limited by the technology (and the cost thereof) for the devices that can detect and measure the concentrations of as-yet-unknown "chemicals of environmental concern" (which we mentioned in the last issue). If we are able to measure these chemicals, it will take a considerable time to develop a credible database; during which time, other (similarly troublesome) chemicals are quite likely to appear.

As a "senior citizen," I probably take some medicines that unintentionally show up in the river. There are quite a few of us, and I doubt that very many of us spend any significant time on the river, in the river, or worrying about the river. But most of us think about our real problems of health, socialization, and the limited future.

On top of all these complications, one should remember that we are (almost all) in a financial crisis — the U.S. Geological Survey continues to discuss closing down river gauges, and even the Flood Warning System on the Susquehanna (which is, after all, noted for its floods) is often the subject of potential funding cutbacks. All this not to mention the shutdown of the Federal government.

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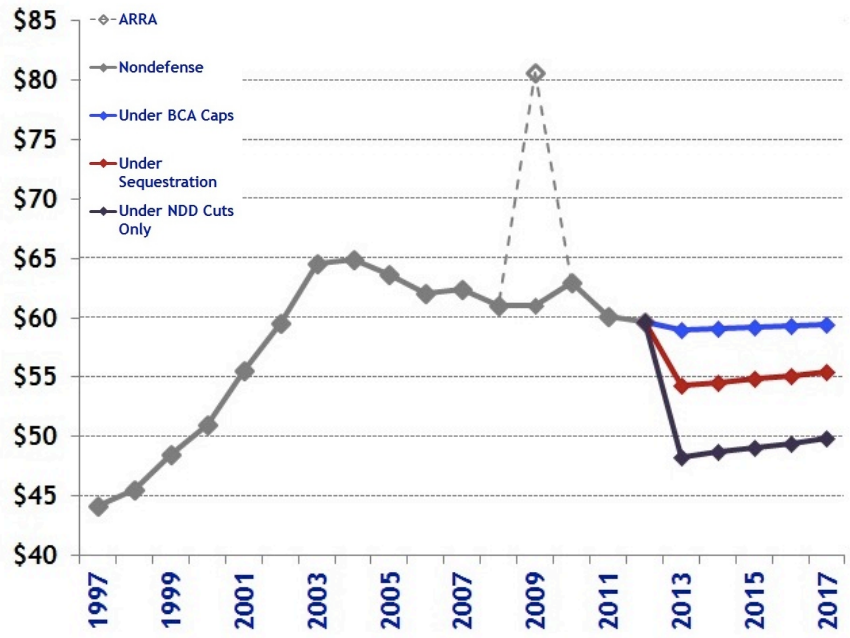
Then there is the matter of "unintended consequences"; it seems that for every well-intended program, there are unintended consequences. Suppose we identify some culprit chemicals in the river — it/they will probably be difficult (and costly) to remove; and there will surely be a government agency ready to implement new standards, with meaningful penalties for violations. Maybe, they will even have funds to assist in construction of new treatment facilities, (see preceding paragraph) but they traditionally require a non-federal match; guess who will pay that!

I suppose the situation can be summarized as a matter of priority; and a lot of folks may not see the state of the river as a very high priority. If we were to compare the total residents of the counties abutting Lake Augusta to the number of those residents who actually use the river, it would give us some idea of the reality of priority.



Federal funding for nondefense research and development (R&D), with and without sequestration (in billions of constant FY 2012 dollars). This year, $58 billion dollars is allocated for general science (NSF, DOE Office of Science, and NASA), energy (DOE), natural resources (NOAA, USGS, EPA), agriculture (USDA), and Health (National Institute of Health). Only a tiny fraction of that amount is available for aquatic research and river health, which saw a 15% drop in budget from previous year. *Source: American Academy for the Advancement of Sciences, 2012.*

Collecting the types of aquatic and geomorphic data needed to assess the health of the Susquehanna is dangerous, time consuming, and physically demanding. It's also fascinating, enjoyable, and of tremendous interest to Bucknell faculty and students. This photo shows Susquehanna River Initiative aquatic biologist Sean Reese holding a crayfish collected during a benthic aquatic habitat survey of the West Branch Susquehanna River near Winfield, PA. Student researcher Molly Gutelius ('15, Geology) and Jared Feint ('16, Neuroscience) record data and take notes.
[Photo: Ben Hayes, Bucknell University Environmental Center Susquehanna River Initiative]

Finally, the matter of a "safe" river depends upon the projected use; swimming in cold water, whether purposely or by accident, is likely to result in hypothermia.

Science can provide some data; and certainly more are needed — but there are also real constraints, and there is the matter of how long a record is required to constitute a reliable database.

It has been said that every issue has as many sides as the number of discussants involved. Consensus is an elusive goal, with a problematic process. We will (hopefully) reach a consensus on the status of the river, eventually—but it will be a long and laborious process. Science has no quick or easy answers; (and, in the final analysis, perhaps no pertinent ones, either!)

Exploring the river

Snapshots

A few photos of recent teaching and research activities of the Susquehanna River Initiative

Bucknell biology professor Elizabeth Capaldi Evans takes her Animal Behavior (ABE 300) students on an educational paddling trip, August 31, 2013.

Management professor Neil Boyd takes his Management for Sustainability (MSUS 300) students on a educational paddling trip, Sept 18, 2013.

Summer research intern Matthew Sirianni ('14) and Geology professor Robert Jacob measure micro-variations in the gravity field near Muncy, PA to detect changes in the depth to bedrock beneath the river valley.

Faculty, staff and students conducting 2013 summer research with support from Bucknell University and the Susquehanna River Heartland Coalition for Environmental Studies. Front [L-R}: Hanna Bohr, Brittany Emigh, Nicole King, Ellen Kalnins, and Dr. Matthew McTammany. Rear [L-R]: Dr. Benjamin Hayes, Matthew Wilson, Molly Gutelius, Jared Feindt, Ryan Murphy, Dr. Donald Duke, and Sean Reese. Absent: Matthew Sirianni and Elizabeth Walters.

Management for Sustainability students gather on the river for a group discussion on consumptive use and water quality concerns facing the Susquehanna River and what sustainable watershed management strategies might help achieve balance between socio-economic forces, urbanization and stormwater management, climate change, river health, and diminishing water resources. The three-hour paddling sojourn was a wonderful way to explore these complex issues together.

View down the West Branch of the Susquehanna River from Rt. 45 bridge at Lewisburg, PA in September, 2013.

The narrow and linear riffle in the foreground is formed by the remnants of a low-head dam built in 1847 to create a navigational pool for canal boats to maneuver across the channel between Montandon and Lewisburg. When flow depths drop to within a few inches as they did this year, pieces of timber cribbing from the core of the dam are visible in the bed of the river.

[Photo: Ben Hayes, Bucknell University Environmental Center Susquehanna River Initiative]

Watching the river flow

Observations

By Fred Swader

A lot of water has flowed down the Susquehanna since our last *River Reporter.* Flows were slighter higher than average in early summer and lower than average in the early fall. All in all, it has been a pretty typical summer. The following tables provide a twenty-year average (1992-2012) and current year (2013) flow rates for April, May, June, July and August, expressed discharge in cubic feet per second (cfs). These figures are derived from data from the U.S. Geologic Survey.

LEWISBURG – The gauge at Lewisburg is the southernmost on the West Branch. It measures the flow from some 7,000 square miles of watershed, and represents about thirty percent of the Susquehanna watershed above Harrisburg.

LEWISBURG	April	May	June	July	Aug.
Average flow (1992-2012), cfs	26,500	12,500	6,970	4,240	6,750
Minimum flow (2013), cfs	9,200	5,500	3,800	3,000	1,450
Maximum flow (2013), cfs	38,000	21,000	22,000	35,000	3,900

DANVILLE – The Danville gauge is the southernmost on the main stem of the river above the confluence with the West Branch. It drains some 11,000 square miles, which is about 46 percent of the Susquehanna watershed above Harrisburg.

DANVILLE	April	May	June	July	Aug.
Average flow (1992-2012), cfs	36,400	18,500	12,600	7,500	6,750
Minimum flow (2013), cfs	15,000	5,500	7,900	4,800	3,400
Maximum flow (2013), cfs	50,000	15,000	38,000	62,000	35,000

HARRISBURG – This is the southern-most gauge for comparison in PA. It measures the flows from drainage of 24,000 square miles.

HARRISBURG	April	May	June	July	Aug.
Average flow (1992-2012), cfs	72,100	41,500	25,600	14,900	22,800
Minimum flow (2013), cfs	32,000	19,000	10,600	12,000	7,000
Maximum flow (2013), cfs	93,000	38,000	55,000	104,000	40,000

Note: sometimes, the flows are almost additive — suggesting the preponderance of the water in the river at Harrisburg was from the parts of the watershed above the confluence, with little additional contribution from the stretch between Sunbury and Harrisburg. At other times, the flows are not additive, indicating substantial inputs from tributaries between Sunbury and Harrisburg, such as the Chillasquaque Creek, Mahantongo Creek, and the Juniata River between. Ultimately, it reflects varying distribution of summer rainfall and groundwater baseflow over the watershed.

SUSQUEHANNA RIVER INITIATIVE

Bucknell UNIVERSITY
ENVIRONMENTAL CENTER

The Susquehanna River Initiative (SRI) creates new teaching, research, and outreach opportunities for faculty and students at Bucknell University. It focuses primarily in the hydrologic, ecologic, and engineering sciences, but also involves the humanities and social sciences, especially related to historical changes in land use, cultures, and communities in the watershed. Sustainability, global connections, and long-term changes are important issues being addressed by the faculty and students involved in SRI studies.

In addition to the river monitoring, aquatic and terrestrial community assessments and habitat studies, the SRI maintains instrumented field stations at the Montandon wetlands and Roaring Creek forested watershed and leads educational paddling sojourns and natural history outings.

Public outreach activities include stream and wetland restoration projects, teaching workshops, annual river symposia, and public seminars.

Environmental data and discoveries are shared with our collaborative research partners, including the Susquehanna River Heartland Coalition for Environmental Studies, U.S. Geological Survey, Chesapeake Bay Commission, Smithsonian Institution, Susquehanna River Basin Commission, Pennsylvania Department of Environmental Protection, U.S. Environmental Protection Agency, and the Nature Conservancy.

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