

BUCKNELL RIVER REPORTER

A QUARTERLY NEWSLETTER BY THE WATERSHED SCIENCES & ENGINEERING PROGRAM

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BUCKNELL CENTER FOR SUSTAINABILITY AND THE ENVIRONMENT (BCSE)

FALL 2016



Figure 1. Eastern hellbender. [photo by Mizuki Takahashi]

Life History and Conservation of Declining Giant Salamander Populations in the Susquehanna and in Japanese Rivers

By Mizuki Takahashi, Ph.D.

Assistant Professor, Department of Biology

Amphibian populations are declining worldwide.

Approximately 41 % of the world's amphibian species are estimated to

be threatened, making amphibians as the most threatened group of vertebrates. Family Cryptobranchidae, known as the giant salamander family, is not an exception. This family consists of three fully aquatic giant salamanders - the hellbender (*Cryptobranchus alleganiensis*), the Japanese giant salamander (*Andrias japonicus*), and the Chinese giant salamander (*A. davidianus*) - and represents one of the oldest salamander lineages.

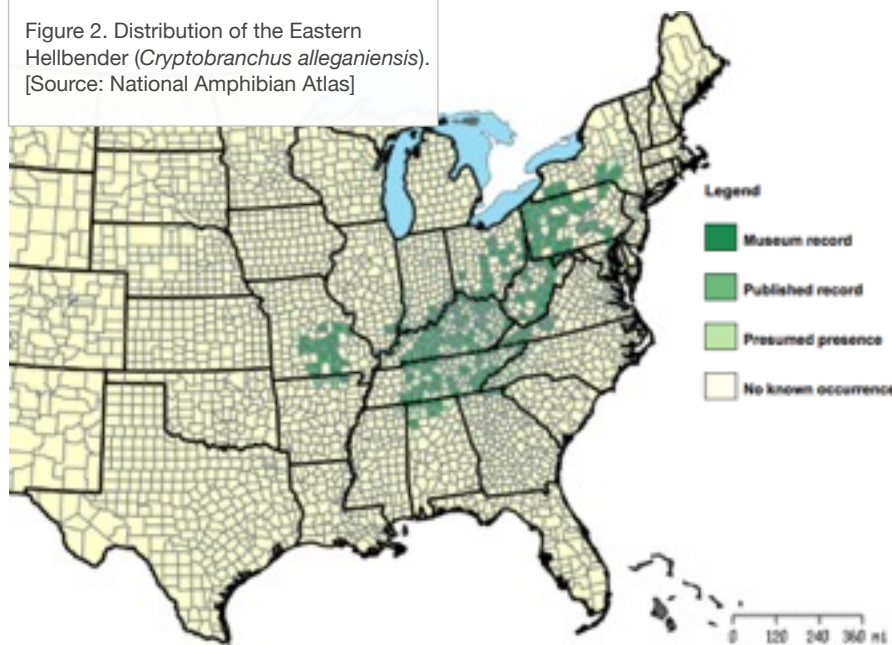
Populations of all giant salamander species have declined for the past decades and these declining trends are not sufficiently

countered by conservation efforts. As top predators, these giant salamanders play vital ecological roles in river ecosystems. In addition, their unique life history, such as prolonged parental care by males, makes them scholarly important species as well.

Unfortunately, many aspects of their life history remain unexplored, and their declining populations making studying these secretive amphibian harder. Below I introduce the giant salamander research projects being undertaken by my lab at Bucknell University.

(continued on next page)

Figure 2. Distribution of the Eastern Hellbender (*Cryptobranchus alleganiensis*).
[Source: National Amphibian Atlas]



Though few locals are aware of it, the tributaries of the West Branch Susquehanna River represent one of the best known regions for the hellbender.

Hellbender (*Cryptobranchus alleganiensis*)

The first project that I would like to introduce is our study of a local species, the hellbender. The hellbender consists of two subspecies, the Ozark hellbender (*Cryptobranchus a. bishopi*) and the eastern hellbender (*Cryptobranchus a. alleganiensis*, Fig. 1).

The distribution range of the Ozark hellbender is limited to the Ozark streams of northern Arkansas and southern Missouri. In response to their recent rapid decline, U.S. Fish and Wildlife Service listed Ozark hellbender as an endangered Species in 2011.

The distribution of the eastern hellbender stretches from northern Alabama/Mississippi to New York

along the Appalachian Mountains (Fig. 2). Despite their wide distribution range, eastern hellbenders are also in a state of decline due to factors such as pollution, illegal harvesting, habitat destruction, and possibly wildlife diseases such as chytrid fungus and ranavirus. As a result, there are a limited number of regions known to harbor healthy populations of eastern hellbenders throughout their wide distribution range.

Though few locals are aware of it, the tributaries of the West Branch Susquehanna River represent one of the best known regions for the hellbender.

One of the conservation challenges we are facing is to grasp their distribution range at a stream level and establish an effective and sustainable monitoring program.

This task is challenging because of their secretive nature, confusion with mudpuppies (another fully aquatic salamander), and the insufficient number of researchers available for covering the wide distribution range.

In addition, the traditional survey techniques, which involve physically finding them by snorkeling and rock turning, require specialized skill, time, and effort since large rocks may need several people to lift and diving gear is needed to reach them.

Such traditional methods also risk disturbing their habitats and reproduction, as well as accidentally causing physical harm to the animals.

(continued on next page)



Figure 3. Water sampling in Pine Creek [photo by Carolyn McPhee]

An environmental DNA or eDNA technique offers an exciting alternative to the traditional survey method. This relatively new technique does not require invasive sampling and assesses target populations through detection of their genetic materials contained in the water. Thanks to the funding from Susquehanna River Heartland Coalition for Environmental Studies, our research lab initiated the hellbender eDNA project last year, using the protocol developed by Dr. Spear (my friend) and his colleagues in North Carolina. Using quantitative PCR, we analyzed 150 water samples (including negative controls) collected from 13 sites across eight tributaries of the Western Branch from June through October 2014 (Fig. 3). Many people including some scientists are still skeptical about the feasibility eDNA technique – detection of animals without seeing them, and so I was to be honest until I saw our results; 1) we found no evidence of contamination in our negative controls, 2) we repeatedly found hellbender eDNA from the streams known to have hellbenders (positive controls), 3) the concentrations of eDNA tend to sharply increase in September, their breeding season, reflecting the signatures of the possible breeding events, and finally 4) we found hellbender eDNA from the streams which do not have current records of their existence. Overall, eDNA technique worked well. This summer, we plan to both expand our sampling area and pinpoint more specific locations of the newly found hellbender populations by conducting finer samplings along the streams.

Japanese Giant Salamander (*Andrias japonicus*)

I have also been involved in a few Japanese giant salamander projects, and spent the last fall in Japan during my leave. The Japanese giant salamander can grow up to 5 ft (Fig. 4) and is widely (though not commonly) distributed throughout the southwestern Japan. Since 1952 the species has been federally protected as a special natural monument designated by the Japanese Agency for Cultural Affairs; this designation is based on its cultural and educational significance. However, the Ministry of Environment, which accesses the conservation status of organisms in Japan, recently raised the status of the Japanese giant salamander from NT (Near Threatened) to VU (Vulnerable). Major conservation issues include damming, concrete banking, habitat destruction, water pollution, and hybridization with introduced Chinese giant salamander. Despite their declining status, the government shows no initiative in conserving this culturally, ecologically and academically important species. This situation is further exacerbated by a lack of researchers and funding. As a result, not only do we fully understand the population status of many sites throughout their distribution range, but we also lack the basic knowledge of its biology and ecology.



Figure 4. The author holding the largest Japanese giant salamander at Asa Zoo, Hiroshima, Japan. [photo by Yuki Taguchi]

Salamanders in Susquehanna Watersheds and Japanese Rivers

by Mizuki Takahashi (continued)

Diving Deeper

My colleagues in Japan and I have studied reproductive ecology of Japanese giant salamander for the past years and provided the first quantitative analyses of male parental care behaviors in this family of salamanders (Fig. 5). Parental care by females is commonly observed among salamanders and is generally associated with terrestrial reproduction with internal fertilization. On the other hand, parental care provided by male salamanders is rare and associated with aquatic reproduction with external fertilization. We found that male Japanese giant salamanders exhibit a diverse array of care behaviors such as 1) tail fanning to provide oxygenated water for the eggs, 2) agitation of the eggs to prevent yolk adhesions and promote healthy embryo development, and 3) removal of unfertilized, dead, or water-mold infected eggs to prevent the infection from spreading over the entire clutch. Our lab is currently collaborating with Asa Zoo in Japan on the analyses of the nesting behaviors recorded by a video camera.



Figure 5. Male Japanese giant salamander caring for the eggs in his nest, Tottori, Japan. [photo by Yukihiro Fukuda]

Our next step is to test the effects of dams on their migration patterns and population health. Since the end of World War II, the construction of dams and concrete banking has been promoted as public-works projects throughout Japan. As a result, it is no exaggeration to say that there are no Japanese rivers without dams. Because Japanese giant salamanders are fully aquatic, dams have likely prevented their migrations and caused population fragmentations. Fragmented populations are susceptible to extirpation (regional extinctions) because of small population size, potential inbreeding, and the lack of breeding sites. Giant salamanders often conduct long-distance up-stream migrations in search of suitable breeding/nesting sites (Fig. 6). My Japanese collaborator observed that a gravid female released eggs at the downstream portion of a low-head dam while attempting to climb up the dam. These eggs were not fertilized and thus wasted. There are also numerous observations that repeated attempts to climb over dams caused serious scrapes on their limbs, which in turn

may lead to secondary infections. Despite these detrimental effects of dams, there is no published study exploring these issues. By using video camera recording and population genetics, the ultimate goal of this project is to provide data for the installation of salamander ladders that enable migration of giant salamanders across dams.

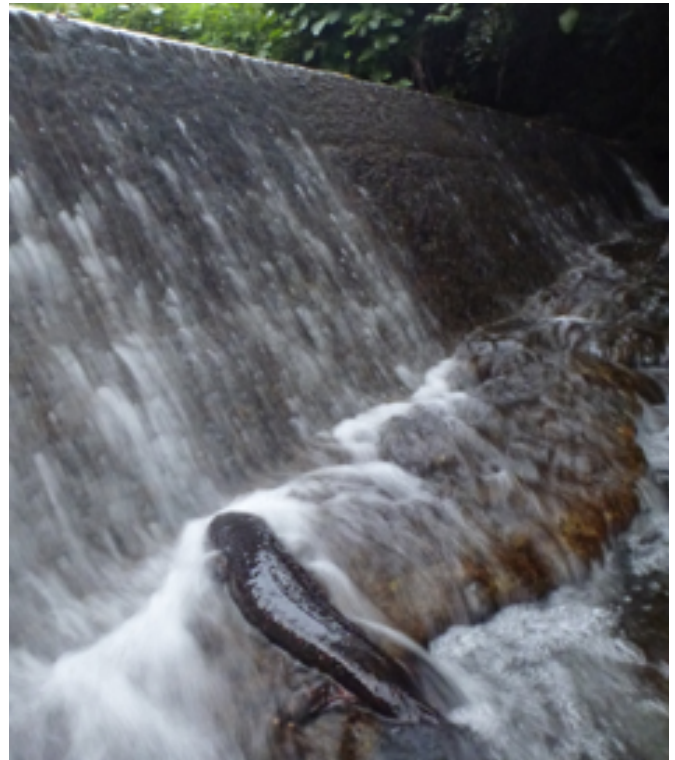


Figure 6. Japanese giant salamander attempting to climb over a dam in Tottori, Japan. [photo by Mizuki Takahashi]

The conservation status of the Chinese giant salamander is worst among the giant salamanders. IUCN (International Union for Conservation of Nature) lists it as “critically endangered”. While farming of Chinese giant salamanders has grown to be a large food industry in China, the information gathered from my colleagues and published literature suggest that the future of the wild populations in China is not bright. In contrast, there is a growing group of university researchers, zoo keepers, and state/federal researchers who strive to conserve hellbenders in the U.S. The current status of Japanese giant salamanders is also much better than that its Chinese counterpart, and its conservation is largely propelled by civilians with nonprofit Japanese Hanzaki (giant salamander) Research Institute and Japanese Giant Salamander Association forming the axis. Our lab hopes to be part of such conservation efforts and to promote collaborative conservation by providing a bridge between the two countries.

We Are Beset!!!

Editorial

By Fred Swader, Ph.D., Faculty Associate

We are constantly amazed at the progress of our society!

World trade continues to grow, bringing us all sorts of goodies; an increasing trade deficit, probably a de-valued dollar, higher petroleum prices, an opportunity to export compressed natural gas, fracking, unlimited withdrawals of river water, more jobs, and all sorts of imported goods.

National policy brings us higher flood insurance rates, increasing environmental requirements, increased taxes, decreased resources to tackle our deteriorating infrastructure, (did I mention increased gasoline prices?), and a whole host of other challenges.

Increased interactions and imports bring us all sorts of good things! Professor Chris Martine discusses in this issue the challenge of Japanese knotweed. And we have a whole lot of other goodies, too; the **Wooly Adelgid** is killing our Hemlock trees, the **Emerald Ash Borer** is doing a number on our Ash trees, and the **Gypsy Moth** has already wrought a lot of havoc on our hardwoods.

And we have the other exotics — Burmese pythons in the Everglades, **Zebra Mussels** in many of our important waters, **Asian Carp** invading the Great Lakes, **Round Gobies** about to take over many fishing areas, MHCM in (some) of our rivers — the list goes on, and on, and on.

Then there weather extremes. Last year was the hottest year on record globally, yet we experienced super-cold winters in the Northeast and Midwest and extreme drought in California, and in the Colorado River watershed. We have paralyzing storms almost everywhere;!

The River Reporter cannot tackle all of these challenges, but we hope, in the next few issues, to provide some information on some of the water-related challenges important to the Susquehanna River, and to those who live in its “Sphere of Influence.”



Asiatic Clam (*Corbicula fluminea*), an invasive mussel species, is now found throughout the Susquehanna River basin. It is thought to be introduced into Columbia River as a food item by Chinese immigrants. The impact of its presence on the aquatic ecosystem is uncertain.



Rusty Crayfish (*Orconectes rusticus*), an invasive invertebrate species, is now found locally in the Susquehanna River. It is a very aggressive species, known to eat and out compete native crayfish species and even eats small fish. The impact of its presence on the aquatic ecosystem is uncertain.



Round Gobies an invasive fish species, is increasingly a common sight in cold tributary streams in northwestern Pennsylvania.



Centre County Pennsylvania Tree Farmer Jim Walizer shows a hemlock branch covered with *adelgid*.



In 2015, gypsy moth caterpillars, which came from Europe and Asia in 1869, caused nearly 700,000 acres of defoliation to Pennsylvania forests.



Flathead catfish, introduced in the lower Susquehanna River for sport fishing, are rapidly making their way north of Harrisburg, PA.

Impact of invasive Japanese Knotweed on riparian forests

By Christopher Martine, Ph.D.

Burpee Professor of Biology, Bucknell University

Invasive plant species can have significant impacts on native flora and natural communities. A recent study conducted by Bucknell senior Biology major Anna Freundlich sought to quantify some of that impact on plant communities along the Susquehanna River.

Under the advisement of Dr. Chris Martine, David Burpee Professor, Freundlich spent several weeks in the riparian forests along the banks just downstream from the Rt. 45 bridge in Lewisburg, PA collecting data on plant species occurrences. In particular, the study focused on the impact of Japanese Knotweed (*Polygonum cuspidatum*) by comparing two study communities along a mile of riverbank: one relatively intact and one heavily invaded by Japanese knotweed.

Her findings show that plots in sites invaded by *P. cuspidatum* are significantly less species diverse than those in intact plots. Species recorded within both communities, such as the common blue violet (*Viola cucullata*), smooth Solomon's seal (*Polygonum biflorum*), and green dragon (*Arisaema dracontium*), had significantly reduced densities in the invaded plots compared to the intact plots.



Japanese knotweed growing along the banks of the Susquehanna at Milton State Park. [Photo: Benjamin Hayes]

Montandon Marsh field research station now includes an instrumented slurry wall

Partnerships

By Benjamin R. Hayes

Central Builders, Inc. and the Merrill W. Linn Conservancy for Land and Waterways partners with the Bucknell Center for Sustainability and the Environment to ensure that Bucknell's long-term teaching and research activities can continue at Montandon Marsh and the nearby active sand and gravel mine. The site is located directly across the river from the Bucknell campus in Northumberland County, Pennsylvania. For over sixty years, Bucknell faculty have been leading field trips to study the botany, geology, hydrology, and ecology of the area. Over a decade ago, Central Builders deeded ownership of the wetland to the Linn Conservancy, which offers educational tours of the marsh for the public. WSE Program scientists Ben Hayes and Sean Reese conduct periodic inspections of the marsh, monitor ground and surface water conditions, and environmental restoration efforts at the site.

All of these conservation and academic activities are made possible through the cooperation of the landowner, Central Builders, and their plant manager, Karl Bettleyon, who oversees mining operations at their Northumberland and Montandon facilities.



Montandon Marsh in Northumberland County. View is looking north (up river), with Central Builder's active gravel quarry visible in the distance. [Photo by Benjamin Hayes]



The new slurry wall being installed. Bentonite mixer visible on left and backhoe digging the trench on right. [Photo by Sean Reese]



Karl Bettleyon, manager of mining operations for Central Builders, Inc., helps facilitate teaching and research activities by Bucknell faculty, staff, and students at Montandon Marsh. Here he inspects one of the new groundwater monitoring wells installed near the slurry wall after he landscaped the disturbed area. [Photo by Benjamin Hayes]

For over twenty years, Karl has allowed access to the wetland and gravel plant for a myriad of teaching and research activities by faculty and students. He has dug test pits for geology students and helped with the installation and maintenance of a network of over twenty ground water monitoring wells and four surface water stations. "Central Builders is pleased to partner with Bucknell University and the Linn Conservancy at our Montandon site," said Karl. "It provides a great learning experience for the students and faculty from the university and the public through the Linn Conservancy" he added.

A recent grant from the National Science Foundation has enabled Michael Malusis and Jeffrey Evans, professors of civil & environmental engineering, and Rob Jacob, associate professor of geology & environmental geosciences to design, install, and test the new buried slurry wall facility. GeoSolutions, renowned experts in slurry wall construction, oversaw the excavation and placement of the bentonite slurry. The facility is designed for long-term data collection and analysis that can continue for a decade or more and potentially affect construction standards worldwide.

In the field and on the water

Teaching and research activities by Watershed Sciences and Engineering faculty and students

Snapshots



James Gutelius, director of Civil Engineering labs, (left) oversaw drilling and installation of groundwater monitoring wells around the new slurry wall facility at Montandon Marsh. [Photo by Brett Simpson, Bucknell Division of Communications]



Richard Crago, Professor of Civil and Environmental Engineering, with Hydrology (CENG 420) students at the solar-powered stream gaging station on Miller Run near the entrance to Bucknell University. [Photo by Benjamin Hayes]



Mike Malusis, Professor of Civil and Environmental Engineering, supervises construction efforts at the new slurry wall facility at Montandon Marsh. [Photo by Brett Simpson, Bucknell Division of Communications]



Civil Engineering students in Jessica Newlin's River Engineering (CENG 422) class measure stream cross-sections, discharge, and the distribution of sediment size on the channel bottom. [Photo by Sean Reese]



Civil and Environmental Engineering student Gareth Messman '17 and Professor Matthew Higgins helped install a v-notch weir to measure flow into one of the agricultural treatment wetlands installed at Ards Farm in Lewisburg, PA. [Photo by Benjamin Hayes]



Rich Crago leads a group of Hydrology students on a tour of a Mennonite farm in Union County to look at how water runoff in fields and pastures concentrates into flow paths. [Photo by Benjamin Hayes]

In the field and on the water

Teaching and research activities by Watershed Sciences and Engineering faculty and students

Snapshots



Aquatic ecology and hydrology studies of White Deer Creek continue to serve as cornerstone of the WSE program. Here Sean Reese and students conduct a fish community assessment. [Photo by Benjamin Hayes]



Beth Capaldi, professor of biology and animal behavior, takes her senior seminar (ANBE 320) students on an educational paddling trip down the West Branch Susquehanna River, partly as a bonding experience and also as a fun, on-the-water classroom. [Photo by Benjamin Hayes]



Biology students Sean Dubois and Edward Carrington conduct underwater surveys and measure density and distribution of native gastropods to determine the impact of invasive crayfish on the benthic communities. [Photo by Sean Reese]



Craig Kochel and Ben Hayes lead their Stream Restoration (GEOL 298) students on a trip up Lycoming Creek to study the design and construction of traditional stream restoration structures and fluvial processes in gravel bed streams. [Photo by Benjamin Hayes]



Dorothy Merritt, professor of geology at Franklin and Marshall College, leads Bucknell students on a tour of their mill pond legacy sediment removal and stream restoration project at Big Springs near Lititz, Pennsylvania. [Photo by Benjamin Hayes]



Summer student researchers joined together for a high-tech work party and installed a network of state-of-the-art weather station and water level instruments at the agricultural treatment wetlands at Ards Farm in Lewisburg, PA. This work is being done in cooperation with Ards Farm, the Union County Conservation District and the Buffalo Creek Watershed Association. [Photo by Benjamin Hayes]



www.bucknell.edu/riversymposium

Bucknell University will host "A Tale of Two Rivers: the Susquehanna and the Delaware," the eleventh annual Susquehanna River Symposium, on Friday, Nov. 11, and Sat., Nov. 12, in the Elaine Langone Center. University president John Bravman will offer opening comments on Friday, and academic provost Barbara Altmann will open the Saturday session. Registration is required only for exhibitors and those giving oral or poster presentations. General symposium attendees are not required to register. The event is open to the public, free of charge.

"After focusing solely on the Susquehanna River watershed for the past ten symposia, we are excited to expand this year's event to include the Delaware. There are both similarities and distinct differences between the two river basins, not only in hydrology, geology, and ecology, but also in land use and natural resource extraction, infrastructure, estuaries, and water law and policy," Hayes says. "We are very excited about broadening the scope of this symposium and look forward to the conversations and discussions that will take place."

The symposium keynote address will be presented on Friday evening by Bernard W. Sweeney, Ph.D., director, president, and senior research scientist at the Stroud Water Research Center in Avondale, PA. Sweeney's research interests include the role of water quality monitoring in conservation, population and community ecology of temperate and tropical aquatic invertebrates, pollution assessment in temperate and tropical streams using macroinvertebrates, and the role of streamside forests in the structure and function of stream and river ecosystems. He previously served as vice-president of the Environmental Group of the Academy of Natural Sciences of Philadelphia and is an instructor in the University of Pennsylvania's biology department.

On Saturday, plenary speakers include Raymond G. Najjar, professor of oceanography at the Pennsylvania State University, Jeffrey Chaplin, supervisory hydrologist at the U.S. Geological Survey Pennsylvania Water Science Center, Gerald Kaufman, executive director of the Delaware Water Resources Center and professor of public policy at the University of Delaware, and Alexandra Campbell-Ferrari '09, executive director of the Center for Water Security and Cooperation.

In addition to the robust research poster session and keynote presentation on Friday evening and plenary speakers on Saturday that past symposium participants have come to expect, this year's event also will include a pre-symposium workshop on Friday afternoon and oral presentations and a new networking social event on Saturday.

James P. Shallenberger, manager of the Susquehanna River Basin Commission's Monitoring & Protection division, will present a workshop "Correlation of In-stream Turbidity with the Arrangement of Catchment Roads Using Precision Analytics" on Fri., Nov. 11. The workshop is open to the public free of charge, but seating is limited. To reserve a space contact the Bucknell Center for Sustainability and the Environment by email at bcse@bucknell.edu.

The new networking social event, featuring exhibits and display tables offers an opportunity for students, faculty, staff, and community members to connect with other participants. Representatives from state and federal environmental agencies, private consultants and industry leaders, private foundations, and conservancies and watershed groups will be available to answer questions. Representatives from the morning's breakout sessions will summarize their discussions, and awards will be presented for best student presentations.

Watching the river flow

By Sean Reese and Benjamin Hayes

Observations

With rocks protruding from the river bed and gravel bars exposed, paddlers on the Susquehanna have been commenting that the river is especially “boney” this year, after one of the driest summers in decades. Water levels in nearby marshes, ponds, and lakes are well below normal. The Pennsylvania Fish and Boat Commission has restricted fishing on sections of Penns Creek and Loyalsock Creek to limit stress on trout populations. At Lewisburg, flow in the West Branch has been only 30% to 50% of the historic long-term daily average discharge for April, June and July. Flow in the North Branch and mainstem was also well below the historic mean.

LEWISBURG is the southernmost station on the West Branch and measures the flow from some 7,000 square miles of watershed, or about thirty percent of the watershed above Harrisburg.

LEWISBURG	Apr	May	Jun	Jul	Aug
Historic mean (1930-2016), cfs	21,500	14,500	8,580	4,840	3,670
20-year mean, cfs	17,570	12,983	7,196	4,687	3,974
Minimum daily flow, cfs	5,550	6,250	2,040	1,130	1,010
Maximum flow, cfs	16,200	19,000	7,190	1,890	2,840
Average, cfs	8,490	10,640	4,264	1,477	N/A

DANVILLE is the southernmost station on the main stem of the river above the confluence with the West Branch. It drains some 11,000 square miles, or about 46 percent watershed above Harrisburg.

DANVILLE	Apr	May	Jun	Jul	Aug
Historic mean (1905-2016), cfs	34,600	19,100	11,100	6,690	4,940
20-year mean, cfs	32,073	18,745	13,197	8,638	6,145
Minimum flow, cfs	9,610	5,500	2,650	2,140	2,840
Maximum flow, cfs	32,300	24,100	9,700	3,940	11,000
Average, cfs	17,080	13,370	4,937	2,608	N/A

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

HARRISBURG	Apr	May	Jun	Jul	Aug
Historic mean (1890-2016), cfs	71,300	44,400	26,400	15,600	12,000
20-year mean (1996-2016), cfs	62,892	42,744	26,930	17,000	13,095
Minimum flow, cfs	19,500	19,200	7,380	4,600	5,580
Maximum flow, cfs	55,300	51,000	22,200	7,710	12,100
Average, cfs	31,530	31,950	13,310	5,769	N/A

*Daily flow rates are reported in cubic feet per second (cfs).
Data provided by the U.S. Geological Survey.*



Susquehanna River at Liverpool, Pennsylvania.

[Photo by Benjamin Hayes]

WATERSHED SCIENCES AND ENGINEERING



The BCSE Watershed Sciences and Engineering (WSE) Program creates new teaching, research, community outreach, and university service 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 WSE studies.

In addition to the river monitoring, aquatic and terrestrial community assessments and habitat studies, the WSE maintains instrumented field stations at the Montandon wetlands, White Deer Creek, and Roaring Creek forested watershed and several locations on the Susquehanna River. It also 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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Editorial Team:

FRED SWADER, Ph.D., *Editor*

BENJAMIN HAYES, Ph.D.

SEAN REESE, M.S.

Mailing Address:

Bucknell Center for Sustainability
and the Environment

One Dent Drive

Lewisburg, PA 17837

Tel: 570-577-1830

www.eg.bucknell.edu/wse



Looking Ahead

Assessing local streams and urban drainages

The Watershed Sciences and Engineering Program periodically offers a course entitled “*Stream Restoration*” (GEOL 298), where students learn about process-based approaches to restoring degraded geomorphic and ecologic environments. During the Spring 2016 semester, students in that class conducted a preliminary assessment of the Limestone Run watershed, including Bull Run, an urban drainage in downtown Lewisburg (*shown in photo below*) and Miller Run, a highly-degraded entrenched stream that flows through the campus of Bucknell University. A synopsis of their findings will be featured in the next issue of the *Bucknell River Reporter*.

