West Virginia Water Research Institute
Annual Technical Report
FY 2016

Introduction

West Virginia Water Research Institute

The West Virginia Water Research Institute is dedicated to the preservation and restoration of the natural environment through research and outreach with industry, government agencies, academia and the public.

Introduction

Water is one of West Virginia's most precious resources. It is essential for life and our economic prosperity, yet so many of the activities that keep our economy alive, and growing, also threaten our water resources. Energy generation, mineral extraction, agricultural production and other industrial activities all impact our water, making it increasingly necessary to find new ways to protect and restore this vital commodity as our economic activity accelerates. For over 40 years, the West Virginia Water Research Institute (WVWRI) has been leading the important work of addressing these issues and is the go-to organization for solving West Virginia's water-related problems.

While much of the work we do is focused on exploring and implementing technologies to improve and protect the quality of our State's water resources, we are also dedicated to expanding the understanding of threats and opportunities related to this critically important resource. We strive to bring together a diverse cross section of stakeholders to participate in water-related research throughout West Virginia. We encourage a constructive and respectful dialog about the future of our lakes, rivers and streams as well as our groundwater supplies.

Today, the WVWRI continues to grow its established programs and develop new initiatives to address emerging problems affecting the State's environmental and economic health. With financial support from State and Federal partners, private foundations and industry, and through the efforts of our staff and collaborating researchers, the WVWRI continues to work for real improvements to West Virginia's water resources.

Water Research for West Virginia: A Team Approach

In 1967, under Federal legislation, the United States Geological Survey established the West Virginia Water Research Institute (WVWRI) to conduct research related to water issues in the State. Today, the WVWRI develops state water research priorities with oversight and guidance from the West Virginia Advisory Committee for Water Research, a committee represented by members of Federal and State agencies, academia and industry. Our programs and projects develop strong, multi-disciplinary research teams through collaboration with West Virginia University colleges and divisions, higher education institutions across the country and industry professionals. This team approach offers the best expertise available to address West Virginia's water issues and allows the WVWRI to perform research in a number of areas at any given time. More information on WVWRI programs, research, projects, initiatives and publications can be found at www.wvwri.org.

Funding Strategy

The Institute uses funding received from the U.S. Geological Survey Clean Water Act section 104b program and State funding to develop research capabilities in priority areas and to provide service to State agencies, industry and citizen groups. Our strategy relies on using the USGS section 104b funding to develop competitive capabilities that, in turn, translate into successful proposals funded by a broad spectrum of Federal and State agencies.

Our strategy also relies on maintaining a broad cadre of researchers within WVU and other institutions within the state. We also work with faculty from institutions across the country to form competitive research partnerships. As West Virginia University is the State's flagship research institution, its researchers have played the dominant role. Our funding strategy relies on successful competition for Federal dollars while teaming with State agency and industry partners. The later provide test sites, in-kind support and invaluable background data. The institute has fifteen full-time and one part-time staff. We are adding two more full time staff positions this year. The Institute also supports numerous students; typically 3-4 GRA's and 2-3 undergraduate students within the WVWRI and more through other departmental projects. All but two positions are supported entirely on external grant funds. Roughly two-thirds of the Institute staff is directly engaged in research projects; the remaining is engaged in community economic redevelopment, outreach, and administration.

Research Program Introduction

The WVWRI has one research project upon which to report:

2016WV223B Environmental STEM Research Program: WV University/ Boy Scouts of America Summit Bechtel Reserve

Environmental STEM Research Program: West Virginia University/Boy Scouts of America Bechtel Summit

Basic Information

Title:	Environmental STEM Research Program: West Virginia University/Boy Scouts of America Bechtel Summit
Project Number:	2016WV223B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	WV-001
Research Category:	Biological Sciences
Focus Category:	Climatological Processes, Ecology, Water Quality
Descriptors:	None
Principal Investigators:	Paul Ziemkiewicz, Richard Thomas, Nicolas Zegre, Todd Petty, James Anderson, Tamara Vandivort

Publications

There are no publications.

Environmental STEM Research Program: West Virginia University/Boy Scouts of America Summit Bechtel Reserve

Annual Report

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Abstract

West Virginia, with its mountainous terrain, multitude of streams and rivers, and energy resources (coal, oil, and natural gas) has been challenged with striking a balance between developing its energy resources and protecting its natural, non-energy resources. Energy extraction, manufacturing, and recreational activities add economic opportunities to the State. All these activities as well as electric power generation, river transportation, and human consumption require water. The State's water resources are at the heart of this tug-of-war between every activity that requires water. Now add to this the potential threat of climate change on water resources.

A key component in attempting to strike this balance in competing uses for water is education. In 2007 a unique opportunity was sprouting which would introduce multitudes of young people to the State and its resources.

In 2007, the Boy Scouts of America (BSA) was looking for a permanent location for the National Scout Jamboree. They were also looking for a fourth high adventure base to accommodate a large number of Scouts who have been wait-listed at the other three high adventure camps every year. What transpired was the selection of property in West Virginia not only as a venue for the Jamboree and a high adventure base but also a summer camp and a leadership center all housed on the same property.

The Boy Scouts of America Summit Bechtel Reserve provides a perfect opportunity to educate large numbers of scouts and their adult leaders on the importance of the environmental STEM field. The Reserve is the BSA's fourth high adventure camp and permanent home of the National Scout Jamboree.

Coordination between West Virginia University and the BSA has resulted in the development of environmental education and research opportunities for America's next generation. This project seeks to give participants a sound appreciation of West Virginia's water resources, the need to use them wisely, and to pass on such information to others in their lives.

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Executive Summary

The Environmental Science, Technology, Engineering and Math (E-STEM) Research Program: West Virginia University/Boy Scouts of America is a research and education project centered on the Boy Scouts of America's (BSA) Summit Bechtel Reserve located in Mount Hope, West Virginia. Led by the West Virginia Water Research Institute (WVWRI), the project set up an ecological monitoring network that provides the framework for a robust and immersive environmental education curriculum intended for scouts and other youth organizations.

During the first year of the project, efforts were focused on installation of research equipment, collection of data, and development of an E-STEM curriculum. All curriculum has been developed and will be piloted and launched during year two of the project.

Research equipment installed includes: one phenocam, one climate station, and two bioacoustics sensors. Data from the bioacoustics sensors was collected, analyzed, and produced into a report to identify the various bird and anuran species which populate the Summit Bechtel Reserve. The phenocam is functional; however, troubleshooting is still being done to obtain remote access to the data. The climate station is collecting data. This data is routinely collected and entered into a spreadsheet which will be used to identify long term climactic trends. In addition, the climate data will be a valuable asset for the BSA to help them determine when inclement weather is approaching.

Site Descriptions

Sustainability Treehouse

The Sustainability Treehouse (Figure 1) is a high traffic area near Scott Summit Center. It provides visitors with an immersive, interpretive, and educational experience that echoes the importance of sustainability. Visitors walk through three floors of interactive exhibits to gain knowledge about ecological concepts and green buildings.

John Gottschalk Boardwalk & Causeway

The John Gottschalk Boardwalk & Causeway (Figure 1), frequently called the wetland boardwalk, is a high traffic area bordering Goodrich Lake. This boardwalk connects the scout's camp sites to Scott Summit Center. This boardwalk transects a created wetland that hosts traditional West Virginia flora and fauna.

Goodrich Lake

Goodrich Lake (Figure 1) is the primary water body at the SBR. It is divided into two sections (east and west) separated by a land bridge. The lake is located at the center of the SBR making it a highly frequented area for scouts. The lake is used for numerous activities including fishing, kayaking, and paddleboarding. The John Gottschalk Boardwalk and Causeway runs the length of Goodrich Lake East.

The Canopy

The Canopy consists of several canopy tours that have an average of five platforms that are elevated from the forest ground. Participants ride zip lines to each of these platforms (Figure 2). This gives them a unique perspective of the forest. Each tour has several trained guides stationed on the platforms to assist participants. The red line and yellow line tours are led by trained West Virginia University (WVU) guides. These guides will present the interpretive education curriculum to participants about forest ecosystem services.

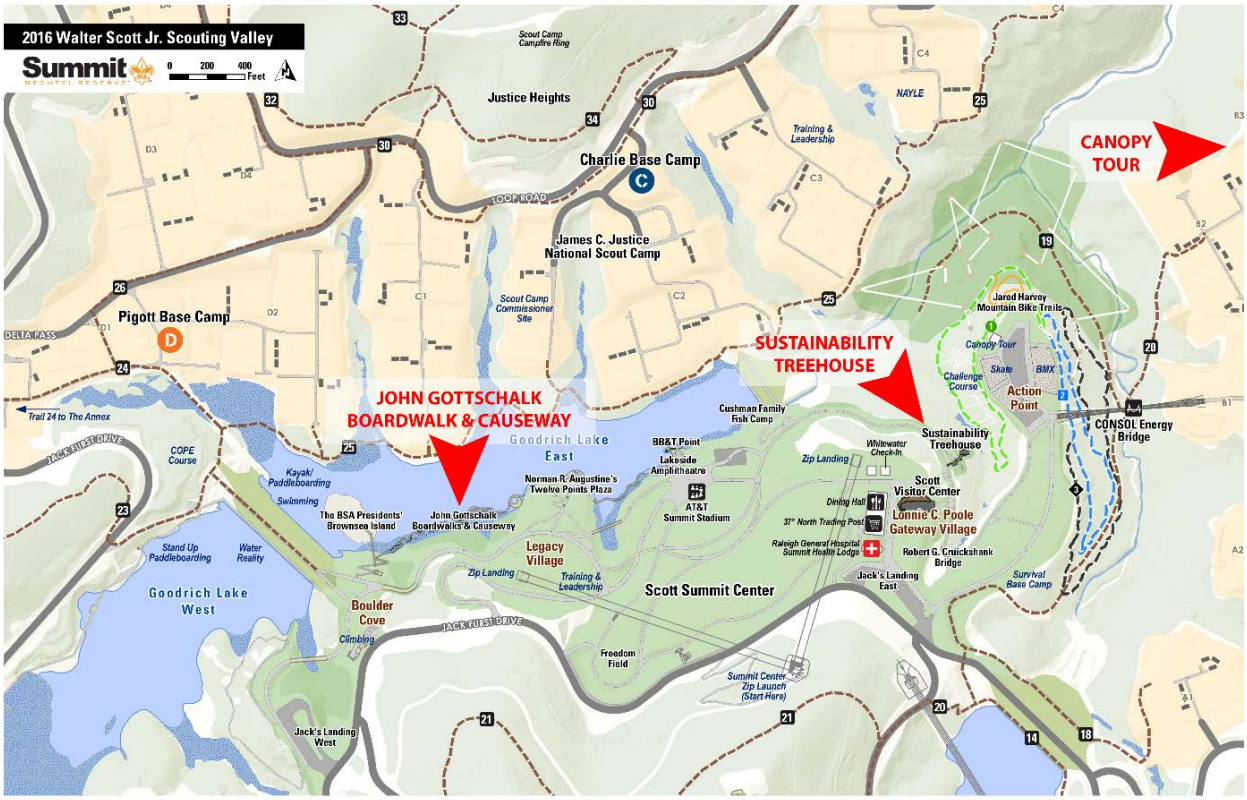

Figure 1. The location of the John Gottschalk Boardwalk & Causeway, Sustainability Treehouse, Goodrich Lake, and the Canopy (Summit Bechtel Reserve, 2016).

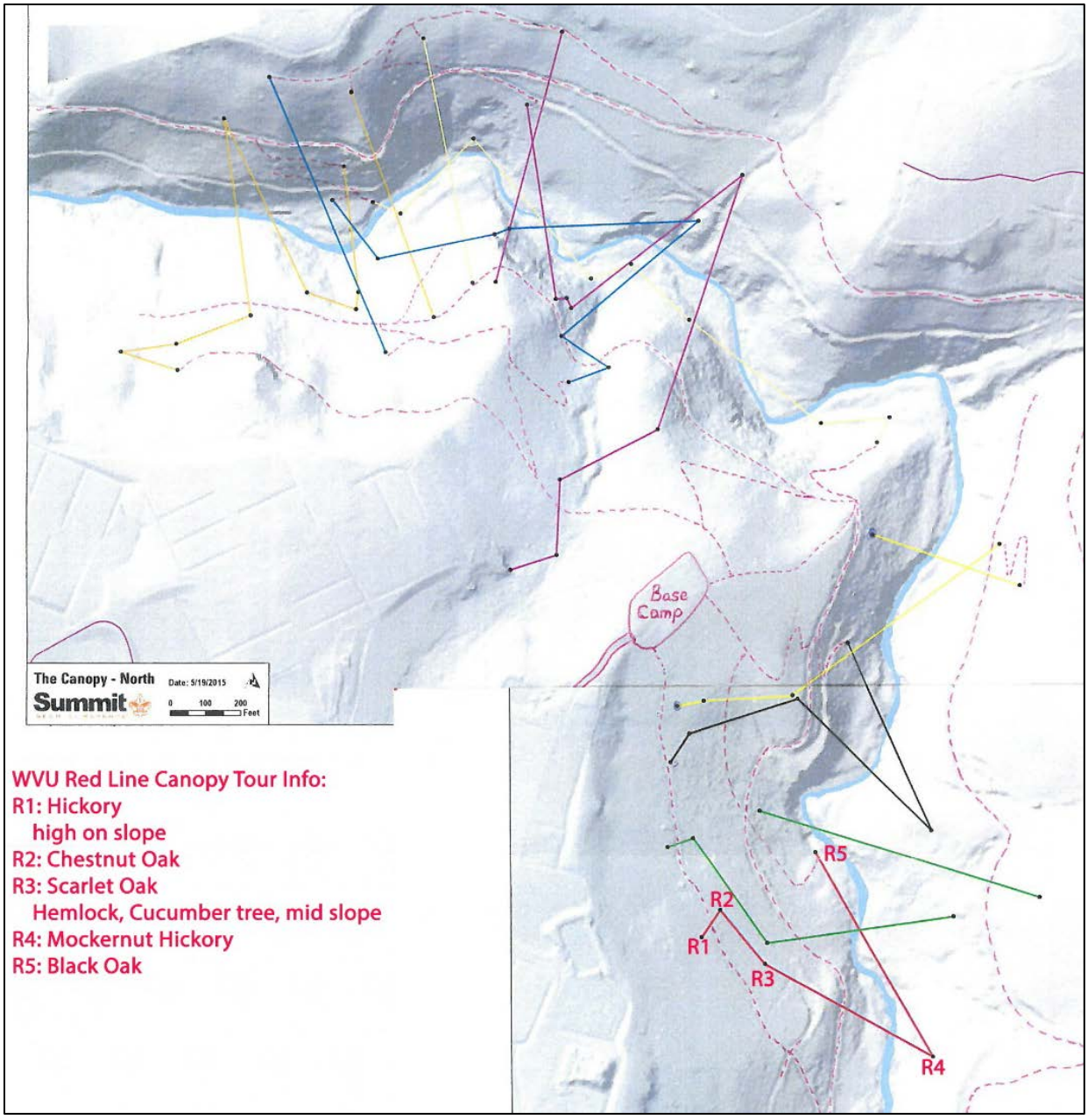

Figure 2. The various canopy tours that are available to participants. Our interpretive education curriculum will be implemented on the red and yellow line tours (Boy Scouts of America, n.d.).

Problem and Research Objectives

In 2009, the Boy Scouts of America (BSA) announced a permanent location for the National Scout Jamboree at Summit Bechtel Reserve (SBR) in Mount Hope, West Virginia. The facility is now fully operational. It serves as BSA's fourth high adventure base and also a summer camp and a leadership center. The site is adjacent to the New River Gorge National River and more than 13 miles of the property border the park, giving scouts access to more than 70,000 acres of managed, Appalachian highlands wilderness beyond the Summit property. Up to 50,000 scouts

are expected to be on site for major events such as Jamborees with about 20,000 cycling through the site every two weeks during the remainder of the summer.

This presents an excellent opportunity to introduce scouts to the Environmental STEM (E-STEM) field, particularly the aquatic sciences, while using the site as an aquatic ecology observatory/laboratory. The West Virginia Water Research Institute (WVWRI) and BSA's SBR have assembled a program to establish a long-term relationship to develop E-STEM education and research opportunities for America's next generation centered on the SBR facility.

There is a growing need to improve our understanding of complex interactions between humans and their environment through projects designed to monitor long-term changes in ecosystem structure and function. Worldwide forest headwater streams are important and stable sources of freshwater (Dudley and Stolton, 2003), but climate change and land cover change associated with human activities have significantly altered the hydrologic cycle. Headwater catchments are particularly sensitive to energy and water balance changes due to their small contributing areas and shallow soils and may serve as a bellwether for the effects of climate change on streamflow (Campbell *et al*., 2010).

Freshwaters are also among the most imperiled ecosystems worldwide (Malmqvist & Rundle, 2002). For example, large-scale anthropogenic impacts (e.g., land cover and climate change) have resulted in the impairment of approximately 40 percent of lotic and 60 percent of lentic freshwater systems in the United States (EPA, 2009).

Another issue is that climate change and human activities such as land cover disturbance are important drivers of the catchment water balance that are directly and indirectly affecting streamflow. Climate and disturbance interact in uncertain ways, potentially mimicking, amplifying, counteracting, or masking their respective effects on streamflow (Jones et al., 2012). The direct effects of climate change will largely depend on how changes in atmospheric conditions (temperature, greenhouse gases) alter the timing, distribution, volume, and type of precipitation and subsequent influences on rainfall partitioning, catchment storage, groundwater recharge, and flooding (Vose *et al*., 2012).

Indirect effects of climate change largely relate to the effects that warming air temperatures and increasing atmospheric CO_2 concentrations have on biological processes that play a key role in the catchment water balance. Transpiration is a major component of the water cycle important to both streamflow, biological productivity, and carbon sequestration. Changes to the processes and conditions that control transpiration have important implications for a host of forest ecosystem services such as drinking water, water filtration, flood control, and carbon sequestration. Warming air temperature has the potential to increase plant water use by providing more energy for evaporation and transpiration (collectively evapotranspiration, ET) altering soil moisture, groundwater recharge, and streamflow (Vose *et al.*, 2012). The objective of this work is to quantify different components of the energy and water balances to explore the linkages between a warming climate and ecosystem services derived from Appalachian forests that will be used as the basis of E-STEM education curriculum focused on freshwater provision and carbon sequestration.

Anurans and other amphibians (frogs and toads) are in severe decline; their populations are decreasing by an average of 3.79 percent per year (USGS, 2016). There are several reasons for this decline including human influence, disease, and climate change. Anurans, and amphibians in general, are excellent indicators of changes in the environment. One of the objectives of this project is to determine what wildlife species are using the wetlands at SBR and what ecosystem services the wetlands are providing. By determining this, we can identify species diversity at the SBR as well as provide scouts a clear image on anuran habitat requirements and the importance of these species.

Another objective of this project is to track the length of the seasons at SBR and determine how the seasons are affecting plant and animal phenology. Current research shows that spring is advancing in 76 percent of U.S National Parks when compared to historical data (Monohan *et al*., 2016). These changes in seasons can have ecological impacts that create implications for interacting species and their community structure (Monohan *et al*., 2016). By tracking these changes overtime, we can give scouts an understanding of the impacts that a changing climate has on the seasonality of plants and animals.

There is also a growing need to broaden educational programs designed to teach students the importance of preserving and protecting our freshwater resources. Project-based learning, wherein students are engaged in investigation of authentic problems or projects, is particularly successful in motivating critical and independent thinking (Blumenfeld *et al*., 1991). This is particularly true for STEM subjects, wherein application of project-based and active learning has been shown to positively affect students' achievement and attitudes toward the material (Akinoglu and Tandogan, 2006 and Freeman *et al*., 2014).

The SBR provides an opportunity to engage a wide range and large number of student learners in E-STEM concepts through active and project-based learning. Thus, the objective of this work is to establish a long-term monitoring program that will simultaneously provide data to researchers at West Virginia University regarding long-term changes in ecosystem structure and function, as well as provide the basis of an E-STEM education curriculum. Through the collection and analysis of ecological data at the SBR, students will be able to see first-hand how anthropogenic activities affect aquatic and terrestrial ecosystem structure and function, as well as how aquatic impacts can ultimately impact humans.

Methodology

The project team installed research equipment pertaining to four areas of scientific research: Wetland ecology, ecohydrology, freshwater ecosystems, and phenology. This technology provided the gateway to develop the E-STEM curriculum, focusing on the four research subject areas. The curriculum included an interpretation component whereby we developed interpretive signs to compliment the curriculum and enhance the scouts learning.

Wetland Ecology

To obtain information on avian and anuran species' presence in wetland environments we deployed four SM4 bioacoustics recorders from Wildlife Acoustics at the SBR on June 22 and

23, 2016 (Figure 3). Three units were placed around the lake/wetland complex and one was placed near the stream (Figure 4). Recording units were placed about 1m off of the ground, and attached to trees with bungee cords and a cable lock in relatively inconspicuous areas to avoid drawing attention to them. The units were set to record for a 30 minute block every hour for 24 hours per day. Audio settings were set for "stereo," left and right gain were set at 16 dB, left and right filters were set at 220 Hz, and sample rate was set at 24,000 Hz. The recorders were serviced weekly by changing batteries and memory cards.

Figure 3. Corey Lilly, WVU undergraduate student, deploying an SM4 bioacoustics recorder at the BSA's SBR in June 2016.

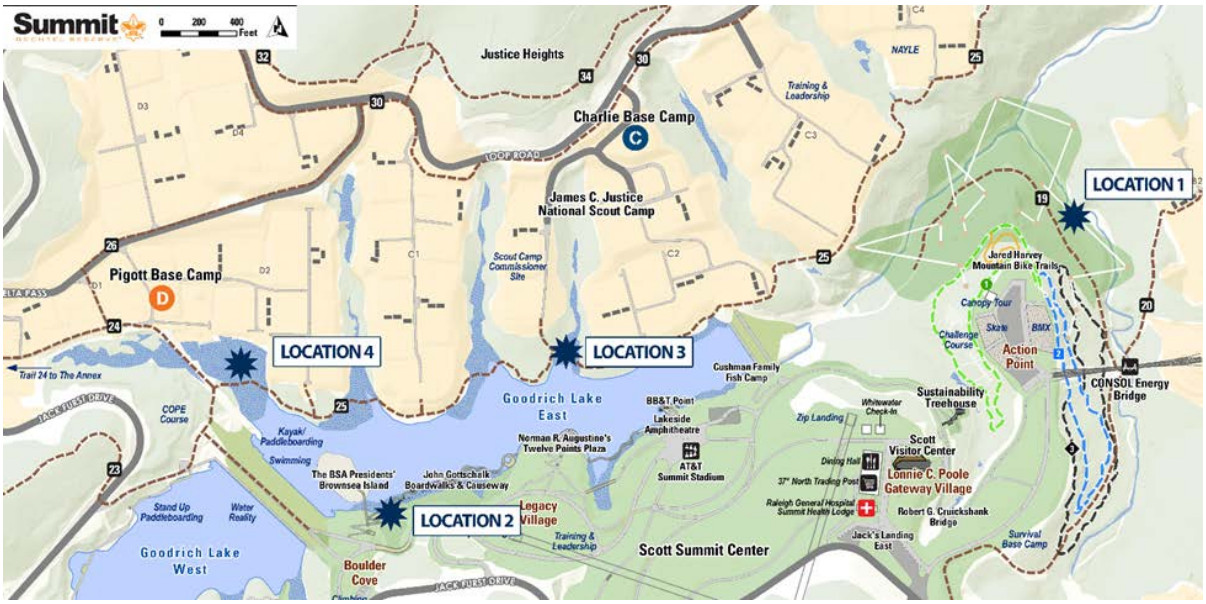

Figure 4. Locations of 4 SM4 bioacoustics recorders installed at the BSA's SBR, during summer 2016.

Prior to analysis of recordings, we developed an expected species list of birds and anurans and established a reference database of vocalizations using sound recordings from Macaulay Library at the Cornell Lab of Ornithology in Ithaca, New York. Our target species included all anurans in West Virginia and a few select birds associated with the lake that we thought would be conspicuous for scouts to identify by sight or sound (Table 1). We used the interactive sound analysis software, Raven Pro ®, to visualize sound frequencies from our recordings to analyze for avian and anuran calls. We excluded any survey days during high winds. For each 30 minute recording file, we manually scanned the recording aurally and visually using the spectrogram created from the Raven Pro ® software. Once a vocalization was identified, we would cross-check it with vocalizations from the Macaulay Library database or, in instances when the species was not included within our database, we would have multiple staff validate the species identification. For each recording file, we documented the presence of each species to provide a total species richness.

Table 1. Anuran and bird species targeted for detection by acoustic recorders.

Common Name	**Scientific Name**
Anurans	
Eastern Cricket Frog	*Acris crepitans crepitans*
Blanchard's Cricket Frog	*Acris crepitans blanchardi*
Northern Spring Peeper	*Pseudacris crucifer*
Mountain Chorus Frog	*Pseudacris brachyphona*
Upland Chorus Frog	*Pseudacris feriarum*
Gray Treefrogs	*Hyla versicolor*

Common Name	Scientific Name
Anurans	
American Bullfrog	*Lithobates catesbeianus*
Northern Green Frog	*Lithobates clamitans*
Northern Leopard Frog	*Lithobates pipiens*
Pickerel Frog	*Lithobates palustris*
Wood Frog	*Lithobates sylvaticus*
Eastern Spadefoot	*Scaphiopus holbrookii*
Eastern American Toad	*Anaxyrus americanus*
Fowler's Toad	*Anaxyrus fowleri*
Birds	
Canada Goose	*Branta canadensis*
Killdeer	*Charadrius vociferus*
Barn Swallow	*Hirundo rustica*
Great Blue Heron	*Ardea herodias*
Belted Kingfisher	*Megaceryle alcyon*

Freshwater Ecosystems

Concerning freshwater ecosystems, activities to-date have largely focused on development of the Freshwater Ecology curriculum. The proposed Stream Ecology area of the program focused on using isotope and eDNA technologies, as well as remote temperature loggers, to provide a curriculum and research program built around stream food-web structure and water temperature modeling. However, upon project award receipt and subsequent trips to the SBR, it became evident that scout access to the few streams on the Reserve was limited. Therefore, focusing the curriculum and research efforts on streams would be very difficult from both a logistical and learning standpoint. Because of this, we chose to switch the focus of both the curriculum and research efforts from streams to Goodrich Lake – the primary lake system on the reserve (Figure 1).

Despite these changes, the current curriculum remains focused on characterizing water chemistry and food web dynamics within aquatic systems. More specifically, the current curriculum and associated research efforts are divided into two separate components dedicated to: 1) stream ecosystem assessment and 2) lake food webs and ecosystem dynamics. The stream ecosystem assessment component focuses on having scouts assess the chemical and biological properties of a small stream that enters Goodrich Lake. We are currently working on obtaining sensors (stream temperature, pressure, and perhaps a DIY conductivity sensor) to place in the demonstration area. The lake food web and ecosystem dynamics component of the curriculum focuses on having scouts sample/measure the various components of a lake food web [i.e., phytoplankton (chlorophyll sensor), zooplankton (light traps), and larval fish (light traps)]. Scouts will also obtain measurements of water chemistry attributes (i.e., pH, temperature, dissolved oxygen) via

handheld sensors and use these measurements to learn how various components of the food web interact with their environment.

Ecohydrology

The ecohydrology research has focused primarily on data collection of the climate system, energy balance, and water balance. A micro-meteorological climate station was installed at the SBR in August 2016 to measure and record various climate variables important to the energy and water balances including precipitation, air temperature, relative humidity, and wind speed. Climate data has been collected continuously every 30 minutes since installation. A photosynthetically-active radiation (PAR) sensor and wind direction sensor will be installed during the spring of 2017. All data is being collected manually until real time data upload and display efforts are completed (target early spring 2017). The primary purpose of the data is to support E-STEM curriculum until a sufficient volume of data is collected and analyzed for research purposes.

Significant field and lab time focused on the development of the sap flux sensors which measure water use of individual tree species. Once installed, the sensors will be a component of the E-STEM education curriculum. Field efforts focused on identifying tree species and candidate trees for sap flux sensor installation. In addition, we have been working with BSA staff to develop a power supply strategy for the sap flux sensors that will be located away from current power supplies. Other field efforts included building a data logger board and sensor configuration responsible for running data collection. Sap flux sensors will be installed in spring 2017. Lab efforts focused on training three students (one undergraduate and two graduate students) on the construction of do-it-yourself (DIY) sap flux sensors from raw materials. As part of student training, we initiated the development of a tutorial that documents the process of building DIY sap flux sensors that we plan to use in future E-STEM-based curriculum for DIY sensors.

Phenology

Phenology component methods have focused on developing scientific and quantitative activities where scouts make observations of phenology, the study of seasonal phenomena, including the timing of animal migrations, leaf development, flower development, and insect emergence. We set up a project site on the Natures Notebook website and collaborated with the National Phenology Network to develop collection observation protocols for SBR. We chose the John Gottschalk Boardwalk and Causeway (Figure 1) that crosses the wetlands along East Goodrich Lake as our first phenology site. Using Natures Notebook, scouts will make observations on approximately 12 plant species, 7 bird species, 7 reptile species, and 1 aquatic insect species. Second, we installed a phenocam (NetCam SC 5MP IR Camera) on a wireless tower at 37 54’58’’ N 81 07’29’69 W overlooking East Goodrich Lake facing northwest towards the tree canopy. This pheno-camera will take three pictures at the same time every day of the year. This will show us important phenophase dates such as leaf out, leaf coloration and leaf senescence. Over time, these data will be used to determine long term trends to see if and to what extent the seasons are changing. The camera was installed at SBR on February 22, 2017. Incorporating this technology into the curriculum will help enhance the scout’s ability to make scientific

observations and develop hypotheses on phenological principals through the power of citizen science.

E-STEM Curriculum

To meet our goal of enhancing the scouting experience and to recruit scouts to WVU, we developed an E-STEM curriculum, to be implemented at the SBR. We created a curriculum based on the four research subject areas: wetland ecology, phenology, ecohydrology, and freshwater ecosystems. Each curriculum contains: 1) the optimal grade level, 2) the content areas, 3) learning objectives, 4) summary of subject matter, and 5) several site specific outdoor activities to engage the scouts in hands-on learning and understanding of the environment. Each section of the curriculum includes a "Science behind the Research" portion that explains the research being done at the SBR, how it works, and why it is important.

This curriculum was developed to be engaging, experimental, fun, and informative. We stayed away from traditional yes/no answers to big environmental questions and, instead, helped guide the students to start using critical thinking and scientific knowledge when they are presented with environmental problems. Over the course of several months, the project researchers met with WVWRI project staff to develop each portion of the curriculum. This gave way to a deeper understanding of how the research could be incorporated into the curriculum. After meeting with the researchers, learning objectives were created for each subject area and learning-based activities were developed. The final version of the curriculum integrated a suite of cross-disciplines: research data, learning objectives, environmental education concepts, interpretive signs and site specific learning activities.

The curriculum can be:

1. Led by a scout leader to correlate with merit badge requirements;
2. Led by a trained WVU employee to have a more in depth learning experience; or
3. Downloaded from the project website and be a self-guided learning experience with help of the interpretive signage at the SBR.

Curriculum Pilot Sessions

We have scheduled a pilot session at SBR for April 8, 2017 to test the effectiveness of the curriculum and any unforeseeable issues with activities. This pilot session will feature the wetland ecology and phenology curriculums. We will schedule another pilot session in May 2017 to test the freshwater ecosystems and ecohydrology curriculum. The canopy tour interpretation is scheduled to be piloted in May 2017 as well. During the pilots we will conduct a pre-test and post-test of questions derived from the curricula. This will give us a percentage of scouts that have successfully met the learning objectives.

Interpretation

The interpretation component consists of the interpretive team (WVU faculty and graduate students) attending project planning meetings, and meeting individually with the project

researchers and an environmental education associate. An interpretive and curriculum plan was developed, with the interpretive components listed below (with brief discussion of connections to curriculum parts as appropriate). The project team collaborated closely as the E-STEM curriculum and interpretive components were developed. The overall education vision was to link the various project parts and, potentially, provide formal and informal educational opportunities for scouts related to each project part, as appropriate. The educational experiences build on each other, or "scaffold" learning opportunities by linking the formal and informal education components.

The interpretive component consists of four parts with various products in each part. They include:

1) Zip line/canopy tour (ecohydrology) (Figure 2)
    a. One large introductory sign for the Kiosk pavilion of the canopy tour is being developed. Topics will focus on forest hydrology and forest ecosystem services.
    b. Small interpretive signs at four stops on the canopy tour are also being developed. These will focus on different aspects of forest hydrology and ecosystem services.

2) Exhibits in the Sustainability Treehouse (Figure 1)
    a. These will display interpretive content associated with the real time and cumulative data from climate and other data sensors on site. The research team is working on gathering content for this. We are working with the BSA to install this.

    b. Sensors include climate station (air temperature, relative humidity, etc.), Lake YSI sensor, sap flux sensors, and stream data. A phenocam has been installed at the SBR. This will provide phenology data (leaf out, leaf drop, etc.) and content will be displayed at the Sustainability Treehouse as well.

3) Three interpretive signs are being developed for display along the wetland boardwalk (Figure 1). Topics include stewardship, mitigation, and phenology/citizen science.
    a. These signs are intended to encourage use of the Nature's Notebook citizen science app and data—focused on wetland plant and animal species.
    b. A graduate interpretive class under the direction of one of the researchers (fall 2016) developed the first draft of the wetland signs and a graduate student is editing them into final versions. The class consisted of four graduate students in interpretive education.
    c. These signs will link to the wetland curriculum.

4) A Freshwater ecosystems sign is being developed and will be installed along the John Gottschalk Boardwalk and Causeway (Figure1).
    a. This sign will correlate with the freshwater ecosystems curriculum.

Outreach

A project website was established to complement the E-STEM curriculum, provide additional resources to program participants, and allow the curriculum to be completed without the assistance of a trained WVU employee.

At the start of the project a press release was issued through WVU to local and statewide media detailing the project. The release was picked up by several newspapers across the state. In November 2016, the project was mentioned in the BSA's blog "Bryan on Scouting," which is seen by BSA adult leaders from across the country

Principal Findings

Wetland Ecology

The four SM4 bioacoustics recorders detected six species of anurans, but only two of our targeted bird species (Table 2). Therefore, we also documented other bird species that were commonly heard on the recordings which added 23 bird species. All anuran species that would be expected around a large body of water during that time of year were detected including the northern green frog, pickerel frog, northern spring peeper, eastern American toad, Fowler's toad, and American bullfrog (Table 1).

Table 2. Anuran and bird species detected on acoustic recorders.

Species	**Scientific Name**	**Loc. 1**	**Loc. 2**	**Loc. 3**	**Loc. 4**
Anurans	*Lithobates clamitans*				
Green Frog	*Lithobates palustris*		X	X	X
Pickerel Frog	*Pseudacris crucifer*		X	X	X
Spring Peeper	*Anaxyrus americanus*		X	X	X
American Toad	*Anaxyrus fowleri*			X	
Fowler's Toad	*Lithobates catesbeianus*			X	
American Bullfrog	*Charadrius vociferus*		X	X	X
Birds	*Poecile carolinensis*				
Killdeer	*Contopus virens*		X	X	
Carolina Chickadee	*Turdus migratorius*	X	X	X	X
Eastern Wood-Pewee	*Melospiza melodia*			X	X
American Robin	*Corvus brachyrhynchos*		X	X	X
Song Sparrow	*Pipilo erythrophthalmus*		X	X	X
American Crow	*Baeolophus bicolor*		X	X	X
Eastern Towhee	*Setophaga pinus*			X	X
Tufted Titmouse	*Setophaga cerulea*	X	X	X	X
Pine Warbler	*Agelaius phoeniceus*	X	X	X	X
Cerulean Warbler	*Lithobates clamitans*			X	
Red-winged Blackbird	*Lithobates palustris*		X	X	X

Species	Scientific Name	Loc. 1	Loc. 2	Loc. 3	Loc. 4
Birds					
Whip-poor-will	*Antrostomus vociferus*			X	
Canada Goose	*Branta canadensis*			X	
White-breasted Nuthatch	*Sitta carolinensis*			X	X
Eastern Phoebe	*Sayornis phoebe*			X	
Northern Mockingbird	*Mimus polyglottos*	X			
Blue Jay	*Cyanocitta cristata*	X			
Hooded Warbler	*Setophaga citrina*	X			
Wood Thrush	*Hylocichla mustelina*	X			
Gray Catbird	*Dumetella carolinensis*		X		
Chipping Sparrow	*Spizella passerina*		X		X
Indigo Bunting	*Passerina cyanea*		X		
Veery	*Catharus fuscescens*		X		
Mourning Dove	*Zenaida macroura*		X		
Pileated Woodpecker	*Dryocopus pileatus*	X			X

Freshwater Ecology

For the freshwater ecology component, to date, all effort has been put toward curriculum development and purchasing and deploying instrumentation needed for the curriculum. Preliminary sampling and data collection has occurred to ensure that the curriculum activities accurately reflect and incorporate ecological conditions on the SBR. Preliminary data, as well as data collected during the 2017 National Jamboree will be stored. Data analysis for research purposes will begin once sufficient data is collected.

Phenology

A phenocam was installed on a wireless tower at 37 54’58’’ N 81 07’29’69 W. The camera is operational (Figure 5). However, due to the strict network security at SBR, we have not yet been able to record data. We are troubleshooting with AT&T so that we can begin data collection as soon as possible. It is expected that we will begin recording data with the phenocam in spring 2017.

Figure 5. The phenocam overlooking Goodrich Lake East at SBR with the tree canopy in the background.

Ecohydrology

The micro-meteorological climate station has been recording climate variables such as precipitation, air temperature, relative humidity, and wind speed since August 2016 (Figure 6). The primary purpose of the data is to support E-STEM curriculum until a sufficient volume of data is collected and analyzed for research purposes. Periodic data gaps exist related to power supply that we are actively working to resolve. All data is being collected manually until real time data upload and display efforts are completed (target early spring 2017).

Figure 6. The micro-meteorological climate station installed at SBR.

Significance of the Project

The outcome of this project is two-fold. The first outcome is the establishment a long-term ecological monitoring station at the SBR that will become a valuable research tool. The second, and perhaps most significant outcome, is the exposure of large numbers of diverse student groups to environmental resource education in an outdoor classroom setting. The experience that these scouts will have at the SBR is unique because, not only will they learn the importance of ecosystem services and preserving freshwater and terrestrial resources through the collection and interpretation of real data, they will do so in conjunction with other experiences, outside of this project, that relate to enjoying clean freshwater (e.g., fishing and whitewater rafting). Thus, scouts will leave the SBR with a far greater understanding and appreciation for their environment than can be learned in any indoor classroom.

Children participating in this curriculum will get a unique experience to enjoy and learn about nature and E-STEM concepts in southern West Virginia. A great deal of children do not get to learn outdoors. Some studies indicate that 95% of their time is spent indoors (Wilson 1996). This can be disadvantageous for several reasons. One being, without having those formative years exploring the outdoors, the child can lack developing positive interactions with the natural environment. Children learn best through immersive, hand-on activities (Wilson, 1996). This curriculum can give them the hands-on learning and the ability to think critically so they can see the value in various ecosystems and foster an ongoing respect for those ecosystems. The participating scouts will also get an inside look at what professions are available in the natural resource field, the research tools used in data collection, and how organizations can make a difference in natural resource management.

Using the project research as the backdrop, the interpretive and curriculum parts of this project work together to develop an integrated suite of informal and formal E-STEM education components.

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Publications

No publications were produced during the first year.

Information Transfer Program

Information transfer for this project focused on the development of an E-STEM education curricula that will be piloted in April and May 2017 with initial widespread deployment in July during the 2017 BSA National Scout Jamboree. Development of the curriculum has involved numerous meetings among collaborators at West Virginia University and the West Virginia Water Research Institute. Project development has also involved meetings with SBR facilities management to coordinate curriculum deployment and that the necessary infrastructure is installed.

We have developed a curriculum that is designed to be continually available to visitors of the SBR – not just to scouts attending National and World Jamborees. In addition to the Boy Scouts, the curriculum is designed to be available for all student groups, including Adventure Scouts, Girl Scouts, 4H, and other youth organizations visiting the Reserve throughout the year. This includes research and sampling equipment that will remain on-site for use in the curriculum activities. Therefore, it is our hope that the E-STEM curriculum will benefit a far greater number of students and scouts than simply those attending various Jamborees.

Student Support

Category	Number of students supported with USGS base grant	$ Value of students supported with USGS base grant	Number of students supported with matching funds	$ Value of student support with matching funds	Total number of students supported	Total $ value of student support
Undergraduate			2	$2,009.52	2	$2,009.52
Masters			2	$4,789.35	2	$4,789.35
Ph.D.						
Post-Doc						
Total			4	$6,798.87	4	$6,798.87

Notable Achievements and Awards

There were no notable achievements and awards during the first year.

Information Transfer Program Introduction

None.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	2	0	0	0	2
Masters	2	0	0	0	2
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	4	0	0	0	4

Notable Awards and Achievements

Dr. Paul F. Ziemkiewicz, Director, WVWRI received the Pioneer Land Reclamation Award from the American Society of Mining and Reclamation (ASMR) for his significant impact and advancement of the art and science of land reclamation over his career.