Eastern Brook Trout Stream Habitat Assessment

Eastern brook trout (*Salvelinus fontinalis*) are the only native trout species in the Chesapeake Bay watershed. They are prized by recreational anglers and have been designated as the state fish of New York, Pennsylvania, and Virginia. Residents of the Chesapeake's headwater streams, Eastern brook trout require cool, clean water. Wild brook trout populations in the Bay watershed have significantly declined over the past two centuries. Factors affecting brook trout include land use and warmer temperatures that degrade high-quality stream habitats, genetic isolation of populations, aquatic passage impediments, and increased competition from other species and the loss of genetic integrity. In the Chesapeake watershed, most brook trout are confined to headwater streams, where disturbance is minimal and forest cover is still prevalent. However, in the headwater tributaries of the Southern Wyoming Valley, there are aquatic passage impediments along the flanks of the valley where Anthracite coal has been mined. The mining impacts caused the downstream areas of many of the tributaries to the Susquehanna River to become disconnected and in need of stream restoration and reclamation to establish a baseflow back to the surface of the land. That work is a large undertaking that would allow downstream migration of isolated populations of native brook trout if the streams were restored. In addition to the stream restoration of base flows and water restoration to perennial flows, addressing Abandoned Mine Drainage treatment needs to be accomplished.

Figure 1. Photo of a native Eastern Brook Trout

The assessment of the streams within the Southern Wyoming Valley is to determine if the habitat and species were present for wild EBT. With NFWF support their recovery efforts of EBT in the Chesapeake Bay watershed is available to expand by maintaining and increasing Eastern brook trout populations in 6 stronghold patches, as measured by a number of effective breeders, consistent with the goals of the Chesapeake Bay Watershed Agreement. The study targeted watersheds, knowing that there was a need to assess the habitat areas to determine if there was a sizeable population or a remnant population due to the severe extent of Anthracite mining that had occurred below the outcropping of the coal measures along the eastern flank of the Southern Wyoming Valley.

The intent of the field investigations was to determine if we could make recommendations to increase habitat integrity in stronghold patches through protection and restoration of riparian areas, stream restoration, nonpoint source pollution controls and land use protections could help restore, improve, and protect Eastern brook trout populations hanging on in the headwaters of the Southern Wyoming Valley. EPCAMR supports NFWF's efforts to increase the size of occupied patches and average patch size through riparian habitat restoration, culvert replacement and road crossings, dam removal, and fish passage improvement activities and where proposed conservation action projects can identify and address potential impacts from the introduction of non-native brook trout species when conducting aquatic connectivity actions.

EPCAMR focused on our regional watersheds in the Southern Wyoming Valley where NFWF had focused on efforts to increase populations in stronghold patches, population units with the highest resiliency to disturbances, likelihood of demographic persistence, and representation of genetic, life history, and geographic diversity. EPCAMR referred to the Eastern Brook Trout (EBT) Conservation Portfolio and Range-wide Assessment Tool (Fesenmyer, et al., 2017).

To assist in determining whether or not the conditions of the streams that had been previously impacted by past mining practices from Anthracite coal mining could serve as an impediment to aquatic fish passage, EPCAMR conducted Aquatic Organism Passage (AOP) assessments on culverts and bridge crossings over publicly accessible haul roads, streets, and roads throughout

the watersheds within the project area using the North Atlantic Aquatic Connectivity Collaborative's (NAACC) protocol for the assessment of aquatic passability for road crossings on non-tidal streams and rivers (Abbott & Jackson, 2019). EPCAMR assumed initially that in areas above the Anthracite coal measures in the bedrock geology, there were isolated populations of native eastern brook trout and other fish species all along the Wyoming Valley, including the Southern Wyoming Valley due to not being disturbed by surface or underground mining.

EPCAMR provided 7 Wilkes University students and 1 Penn-State University student, with accounts to be able to take the AOP and Protocol Training online through NAACC in March of 2022. EPCAMR coordinated with Jacob Smith, a Wilkes University student, President of the Wilkes University Fly Fishing Club, a member of the PA Chapter of the Native Fish Coalition, and an EPCAMR member and volunteer to obtain all of the students names and information needed for the online database of Lead Observers and for the field portion of the training. In April of 2022, EPCAMR provided Jacob with a telescoping stadia rod, 300' tape measure, a 25' tape measure, and the field data survey worksheets for the culverts, pipes, bridges, and structures associated with the infrastructure above the streams that are a part of the larger aquatic connectivity picture. Nikko Simons, EPCAMR volunteer, and Levi Sunday-Lefkowitz, a former EPCAMR Watershed Outreach Intern and volunteer assisted with field data collection with the EPCAMR Staff in the Summer of 2022 and crossing data entry into the NAACC database.

A web-based database serves as a central repository of the data collected in crossing surveys. The EPCAMR Staff were trained in AOP as Lead Observers and certified by the Executive Director in the field, who also serves as a Lead 1 Coordinator for the NAACC and was a Lead Observer initially. The NAACC has finalized two scoring systems to help interpret data collected from stream-crossing assessments:

- A classification scoring approach, where each crossing is assigned to one of three categories based on the degree of aquatic organism passage (AOP) through the structure: full AOP, reduced AOP, and no AOP.

- A numerical scoring approach, where mathematical formulas using the data from the assessment are used to compute a numeric score for each crossing. Scores range from 0 (no aquatic passability) to 1 (full aquatic organism passage).

Upon entry into the database, all crossings are automatically scored by both scoring systems. In the mapping interface, NAACC currently shows only the numeric passability score and associated descriptors. The severity of the barrier is either considered Severe, Significant, Moderate, Minor, or Insignificant. NAACC plans to implement changes in the map viewer that will allow users to choose whether to display the numeric score descriptors or the AOP classification. A description of both scoring approaches can be found here.

The NAACC has completed a HUC12 subwatershed prioritization to help identify sub-watersheds that may be a higher priority for field survey. The prioritization included criteria such as diadromous fish, brook trout, likelihood of crossing failure, greater uncertainty of crossing passability, and impact of crossing failure. The results of the prioritization, which may be viewed for the entire NAACC region or stratified by state, are displayed on a web map and can be explored using a customizable tool for use with ArcGIS Desktop.

Trained Lead Observers certified to assess crossings use a uniform protocol throughout the thirteen-state, North Atlantic region. The protocol includes observations of the crossing (for example road type, flow condition, crossing alignment) and of the structure itself (for example material, shape, dimensions). The Instruction Manual for Aquatic Passability Assessments in Non-tidal Streams and Rivers explains this survey protocol was used with copies of field data forms. The offline data manager (ODM) electronic version was also available for smartphones, tablets, or laptop computers, however, EPCAMR decided that it would be best to write our notes in the field and return to the office to transfer and input data into the database following our field investigations. This protocol's field data form and instruction manual are available under NAACC Documents.

EPCAMR has entered all our field results into the database for each of the watersheds in the project area and created an Appendix of the results of the scoring of the crossings in the

Appendix. For this project, EPCAMR Staff noted if there was a need for streambank restoration, any pipe/culvert alterations, a need for riparian plantings, the presence of invasive plants that could be removed, large woody debris or trash blockages above or below the pipes, culverts, and or bridges, the need for future streamside cleanups, and photos that included in the database upstream and downstream of the crossings.

EPCAMR identified **21** instream field investigation locations of habitat areas along the waterways in the watersheds within the project area included in the map below. These areas were chosen before sampling at each location that was accessible without much data to show what the quality or flow of the waterways was in each. Since high-quality fishing opportunities require healthy, functioning ecosystems comprised of diverse aquatic communities, EPCAMR wanted to investigate the conditions of the streams above and below the coal measures to be able to compare the results that were noted. EPCAMR also wanted to make a correlation between some loss points or infiltration areas, where clean water is being lost to the underground mine workings in the mining-impacted regions of the watershed and resurfacing as abandoned mine drainage (AMD), in other parts of the lower reaches of the watersheds causing deleterious effects on the quality and function of the expected fisheries. Pennsylvania's fish, amphibians, reptiles, and other aquatic resources face several threats, not only with legacy fossil fuel extraction, but with transmission line construction, municipal and industrial surface, and groundwater withdrawals, point source and non-point source discharges, road construction, encroachments, and the introduction and proliferation of invasive species in both plant and aquatic environments.

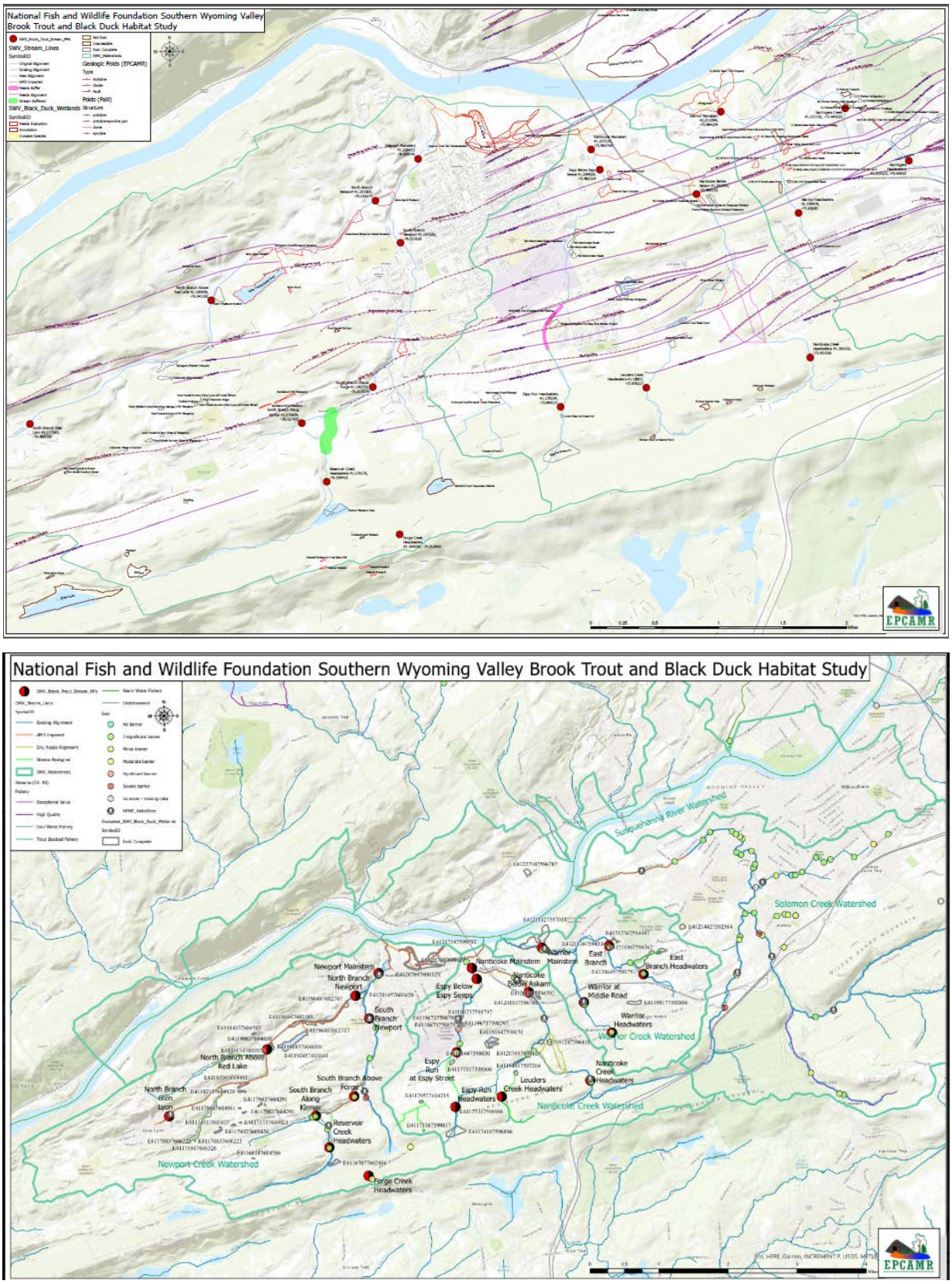

Figure 2. Maps of Potential Monitoring Points for the American Black Duck and the Eastern Brook Trout within the Project Area of the Southern Wyoming Valley

PA Fish & Boat Commission Fishery Surveys

Aaron Frey, Management Area 4 Fisheries Biologist for the PA Fish & Boat Commission (PA F&BC), provided EPCAMR with a copy of their 2012 Unassessed Waters Surveys that did not qualify as Wild Trout Waters. The PA F &BC surveyed thirty-five named streams during the 2012 field season that did not qualify as Wild Trout Waters. They followed procedures in the PA Fish & Boat Commission's Bureau of Fisheries *Sampling Protocols for Pennsylvania's Wadeable Streams* (Miko, D., 2011). Newport Creek (5B), South Branch Newport Creek (5B), Nanticoke Creek (5B), Espy Run (5B) all had water chemistries that precluded aquatic life and/or effective electrofishing. The Middle Branch Newport Creek (5B), and Warrior Creek (5B), each had one dry station. There were no management actions taken for the streams at that time.

The Newport Creek, Middle Branch Newport Creek, and S. Branch Newport Creek are not classified under Title 25, PA Code Chapter 93 Water Quality Standards and are listed as Unclassified (PA Code, 2021). The Nanticoke Creek is classified under the Aquatic Water Use Protections as a Cold Water Fishes (Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna that are indigenous to a cold water habitat) and Migratory Fishes (Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycle in other waters.) at both sampling locations. Espy Run is classified as a Coldwater Fishes, Migratory Fishes. Warrior Creek is classified as a Cold-Water Fishes, and Migratory Fishes at both sampling locations.

EPCAMR and the Luzerne Conservation District suggested a few locations for Aaron Frey to survey and electroshock during the last week of July 2022 below. Locations were selected in reference to Wilkes University's Dr. Ken Klemow's work from 2002 and sites that he had sampled as a part of an assessment report titled, *The Impact of Mining on the Newport and Nanticoke Creek Watersheds, Luzerne County, PA: A One-Year Assessment of Physical and Biological Impacts* (Klemow, 2002).

Nanticoke Creek Watershed Suggested Fish Survey Sampling Locations

- Above Watinski Villa and the bridge where Earth Conservancy and EPCAMR have installed the weir and transducer (This is flow that comes from the one headwater pond on the northeast; There is a small Truesdale Terrace tributary that follows Tomko Avenue and there is another stream that flows into the confluence of that tributary to the southeast right above the bridge on Tomko Avenue in the Nanticoke Creek headwaters)
- EPCAMR has noted fish below the Tomko Avenue bridge where Earth Conservancy has installed the weir and transducer at the end of the concrete channel (Dr. Klemow's Site NK1); Lots of minnows and crayfish have been noted; EPCAMR Executive Director has seen a 12” brook trout in a pool above the loss point; Below this area is a significant flow loss of Nanticoke Creek into the underground mine workings and an ephemeral channel
- EPCAMR has noted plenty of fish warm water species in Espy Run from Espy Street downstream (creek chubs, minnows, black-nosed dace) in the Nanticoke Creek watershed
- Espy Run off Kosciousko Street below Lexington Village development in the Nanticoke Creek watershed
- EPCAMR is not sure if there are any fish in the water and or ponds off Front Street above Clarks Cross Road in Leuder’s Creek, a tributary to Nanticoke Creek; Leuder's Creek is along Front Street above Clarks Cross. It had an old concrete flume project done to restore water to the surface but has fallen into disrepair, and flow is lost into the underground mines at this location. Dr. Klemow sampled it (Site NK5) and the macro community appeared to be mediocre.
- EPCAMR is not sure if there are any fish at the upstream sampling point for Earth Conservancy at the bridge along Middle Road near the Dundee Apartments above the Askam Borehole
- EPCAMR has noted warm water species of bass fingerlings downstream on Nanticoke Creek at the downstream sampling point off the on-ramp to the South Cross Valley
- Espy Run continues to flow off Kosciousko Street below Lexington Village development and into AML toward the Espy Wetland Treatment System; The area is flooded due to beaver activity and dams making it very inaccessible; The area is now the True Value

Hardware Distribution Center. EC has an access agreement and may be waiting on opportunities to submit for grants for operation and maintenance funding

- Nanticoke downstream of the confluence with Espy Run has decent water quality when the Askam Treatment System is running. EPCAMR has noted schools of minnows when the water is not too cloudy

Newport Creek Watershed Suggested Fish Sampling Survey Sites

- Luzerne Conservation District's Watershed Specialist, John Levitsky, suggested Reservoir Run above the waterfall on the PA DCNR Bureau of Forestry Pinchot State Forest Wanamie Tract in the Newport Creek watershed; It is likely to have some good cold water fish species, such as trout. There have been anecdotal stories of trout caught up there; Access is limited by vehicle, so hiking is more suitable, or use of an ATV
- Newport Creek South Branch Headwaters along Kirmar Ave is normally completely dry above the confluence with Reservoir Run
- Newport North Branch Headwaters runs out of Glen Lyon when the Glen Lyon Pump Discharge is running; It is mostly fed by smaller AMD discharges that come in along the railroad corridor. Red Lake (Newport Dump) Discharge adds a lot of cold polluted water before meeting up with the mainstem of Newport Creek. It is interesting to note that in Dr. Klemow's report NP9, NP10, and NP19 seem to have the best macro scores which indicates that enough iron is being removed to support aquatic life and a fishery

For the NFWF Brook Trout Sites, EPCAMR thought about where the best locations after would be reviewing all the information above. For the Coldwater Heritage Plans, EPCAMR would typically go with what was taught in Field Ecology, which is the minimalistic "upstream of confluence" approach. This means we would suggest sampling each stream upstream of the confluence. Then there is one last point we add close to the mouth where the streams empty into the Susquehanna River. This is described in our QAPP and referred to EPCAMR Field Binder page 16 with a figure that is more related to our AMD discharge sampling methods.

If we applied that to Newport Creek that would mean at a minimum sampling these 8 sites:

- NP 22 Main Stem
    - NP 10 North Branch
        - North Branch Headwaters between Glen Lyon and Newport Lake
    - NP 17 South Branch
        - Fairchild Creek below the pond
    - NP 13 South Branch
        - Wanamie Reservoir Creek below the Reservoir
        - South Branch along Kirmar Parkway above Reservoir Creek Confluence (if it is running)

On Newport Creek, EPCAMR left the North Branch Headwaters Site flexible. It all depends on whether the Glen Lyon Pump Discharge is flowing or not. Since the streams are being lost to the underground mines, the North Branch Newport Creek (on topographic maps) is up on the mountain behind the Stearns Culm Piles. EPCAMR has not really explored up there. However, when we went out on the ATV along that railroad grade to monitor that riverine wetland for the American black duck habitat survey and found the Stearns discharge, we did not remember ever seeing a dry stream channel or draw. That area is so heavily stripped, the headwater stream is lost and comes out either the Stearns AMD or Glen Nan East and West seeps. The same is true for the Middle Branch of Newport Creek, which comes from Earth Conservancy Compost Center and Kapik Pond. EPCAMR has explored that area, and the headwater tributary is lost before it crosses under Kirmar Parkway.

Applied to Nanticoke Creek that would mean at a minimum sampling these 6 sites:

- NK 19 Main Stem
    - NK 12 Main Stem
        - NK 1 North Branch Headwaters
        - NK 5 Leuder's Creek Headwaters
    - NK 18 Espy Run
        - Espy Run below Hanover Reservoir

- Espy Run Site 18 could be interchanged with Site 15 if we cannot get access into 18 because True Value is building next to the Espy Run Treatment System.

There are 2 major challenges to be considered. First, are the AMD discharges themselves. Do we consider them "Confluences" and add 2 sites per each (at discharge and just upstream)? This is essentially what Dr. Ken Klemow did in his Report. Second, are the flow losses. For example, we cannot measure an above-ground confluence of Nanticoke and Leuder's along Front Street, so we had to move the sampling sites up to the headwaters where there is flow.

EPCAMR has additional data that was collected of macroinvertebrates from 2004 that can be found in the Appendix.

EPCAMR surveyed the Nanticoke Creek Watershed Reconnaissance on 7/26//22 and the Newport Creek, Warrior Creek, and Espy Run Watershed Reconnaissance on 7-27-22 before the fishery survey with the PA Fish & Boat Commission.

HOBO Temperature Sensor Installment and Deployment and Continuous Monitoring

EPCAMR Staff installed and deployed 16 HOBO temperature probe units throughout the watersheds to obtain temperature readings continuously over time in November 2022. They were TidBiT MX Temp 400 and 5000 loggers. All their specifications were included as a part of our QAPP. Ten of the 16 units provided complete data and 6 of the units experienced technical malfunctioning throughout the project. A few of them were lost to extreme weather conditions even when they were deployed using waterproof epoxy on large boulders. Construction activities around another site possibly led to one of the probes along Warrior Creek to be scooped up and disposed of unknowingly by a machine operator. Vandalism could have been another cause for the loss of a few by curious youth. EPCAMR also purchased PVC bushings and caps to secure the HOBO temperature sensors. EPCAMR researched and reviewed Trout Unlimited's A Handbook for Trout Unlimited Chapters: Stream Temperature Monitoring (Dauwalter, et. al., 2018) and the EPA Best Practices for Continuous Monitoring of Temperature and Flow in Wadeable Streams (EPA, 2014), prior to installing and deploying the HOBO temperature sensors.

The reason for the installations and deployment in each of the watersheds was to see when the streams were flowing continuously or experienced periods of low or no flow. Some of the streams can lose water to the underground mine workings. The data was reviewed to determine when the water temperature was being obtained while it was in contact with running water and when the sensors were out of the water and reading ambient air temperatures to indicate that the site was experiencing low flow conditions, or the area went dry completely. The temperature readings that are charted in the Appendix as hydrographs also indicate the maximum temperature of 70 degrees that eastern brook trout can tolerate before experiencing extreme stress during Summer climate. A red line on each of the charts indicates the upper threshold for the eastern brook trout species. Since we are studying eastern brook trout habitat, we believed we needed to reflect what the temperatures mean to the species.

EPCAMR Program Manager, Mike Hewitt, also calculated the average, minimum, and maximum temperatures for 2023 and 6 months of data for the ones where we were able to obtain some data from them before they were lost to storm events or vandalism. The data shows some

remarkable differences between temperatures downstream of a pond versus an AMD discharge and a suspected flow loss location. Graphs of the HOBO temperature data are in the Appendix.

Temperature readings on some charts indicate much colder water temperatures because they are located downstream of several abandoned mine drainage (AMD) discharges that while not the focus of this assessment, are contributing greatly and are the major factor as to why there is the temperature difference in the streams. The AMD is combined with the stream flow of the creeks and tributaries decreasing the water temperature making them artificially lower than they would normally be without the addition of the mine water pollution. Sedimentation from the AMD is another contributing factor to the water quality at many of the locations where the HOBO temperature sensors are located.

Figure 3. Photo Collage of EPCAMR Installing HOBO Temperature Sensors within the Southern Wyoming Valley Watersheds

North Atlantic Aquatic Connectivity Collaborative (NAACC) Aquatic Organism Passage Culvert Assessment Recommendations for Culvert Repair and Replacement

Without proper maintenance, many local roads could wash out where stream culverts fail to handle extreme water flow or flooding events. The damaged and impassable roads could make emergency response and recovery after storms even more difficult. Poorly designed road culverts are also a year-round, long-term obstacle for fish passage for species such as the eastern brook trout. Stream simulation designs for road crossings at streams and using the Aquatic Organism Passage (AOP) survey results can help with predicting the needs of each crossing. Flow constrictions, increased velocity, depth of water, perched pipes, lack of outlet armoring, and openness of the culverts, pipes, and bridges, all can become problems if they are not sufficiently addressed with the older infrastructure that is commonly what has been found in our coalfield communities. Stream simulation design aims to create channel dimensions like the natural stream channel and have sufficient flow capacity to handle a 100-year flood.

In an article entitled, Flood Effects on Road-Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs in Fisheries (Gillespie et. al., 2014), the magazine of the American Fisheries Society, scientists describe the benefits of stream simulation design for both improving the reliability of the road network and enhancing connectivity for fish and other aquatic species. The study showed that local municipal governments could potentially save money and improve public safety over the long term by investing in improved road crossing designs, culverts, and bridges that have more capacity to perform better and be more resilient during high flow events. Areas, where repeat health and public safety issues are reoccurring and have washed out in the past, identifying priority sites crucial for both fish passage and road traffic passage, improving coordination among state and federal agencies to adopt better standards, and reworking funding structures so states and municipalities can afford to redesign and upgrade their road-stream crossings after flood failures will be key to reducing flood risk, lowering costs for municipalities, and provide a myriad of ecological and watershed community benefits when it comes to the reconnectivity of fish and aquatic organisms in response to current climate change.