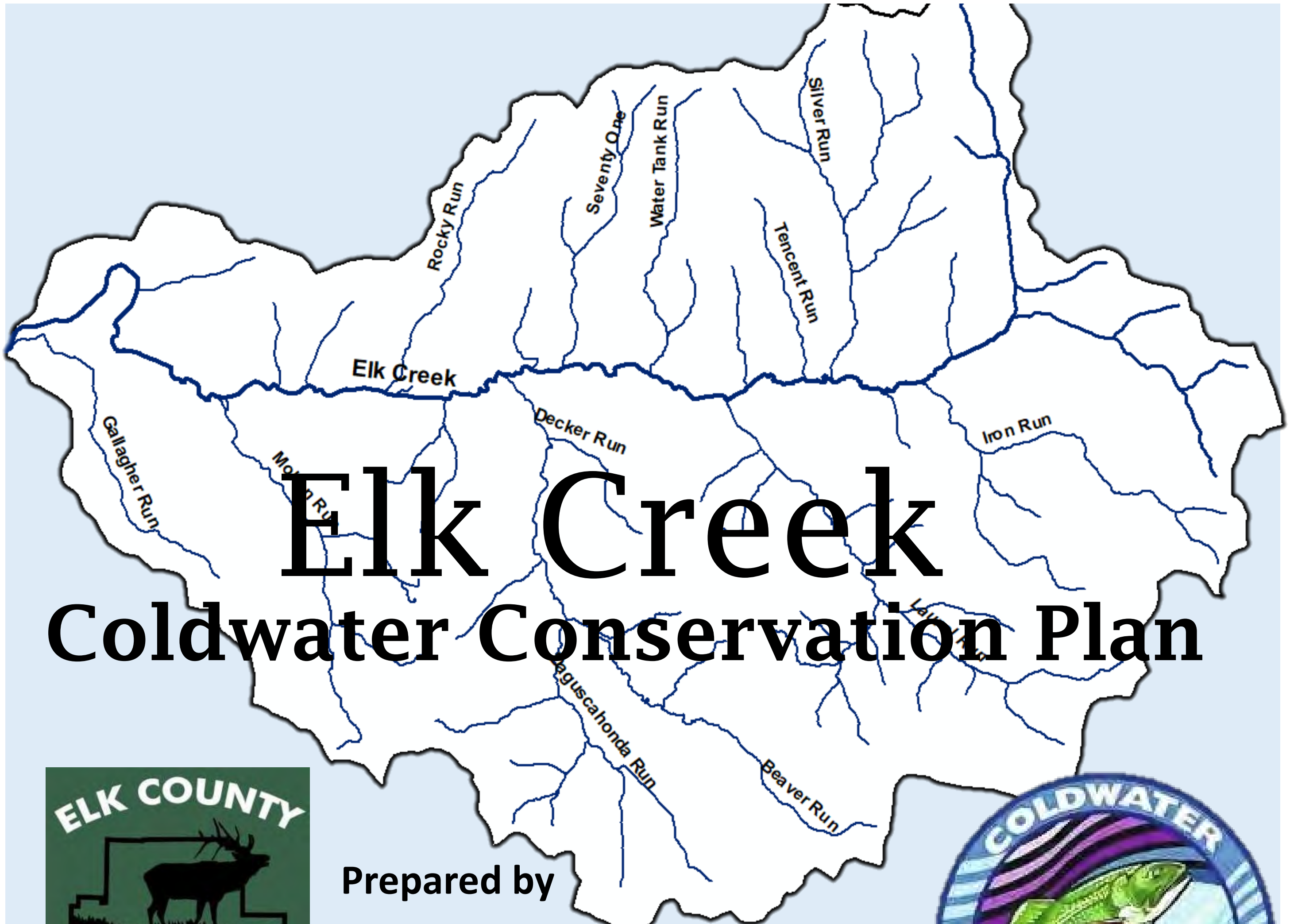


# Elk Creek

## Coldwater Conservation Plan

**Prepared by**

Elk County Conservation District
850 Washington Street
St. Marys, PA 15857
(814) 776-5373

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The cover photo by Mark Hanes, President of Iron Furnace Chapter of Trout Unlimited, features a wild Brook Trout caught in Water Tank Run- a Class A tributary to Elk Creek.

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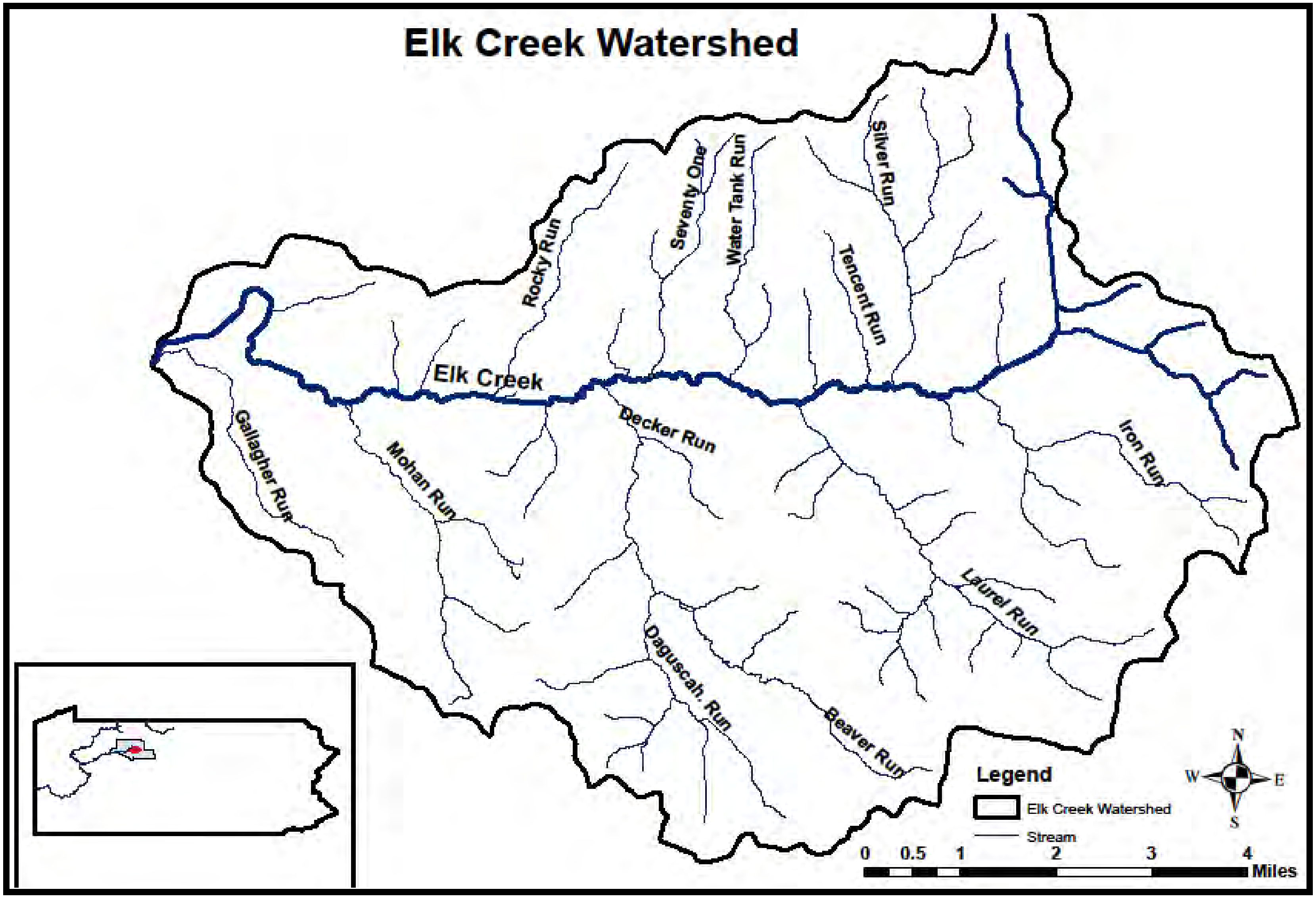


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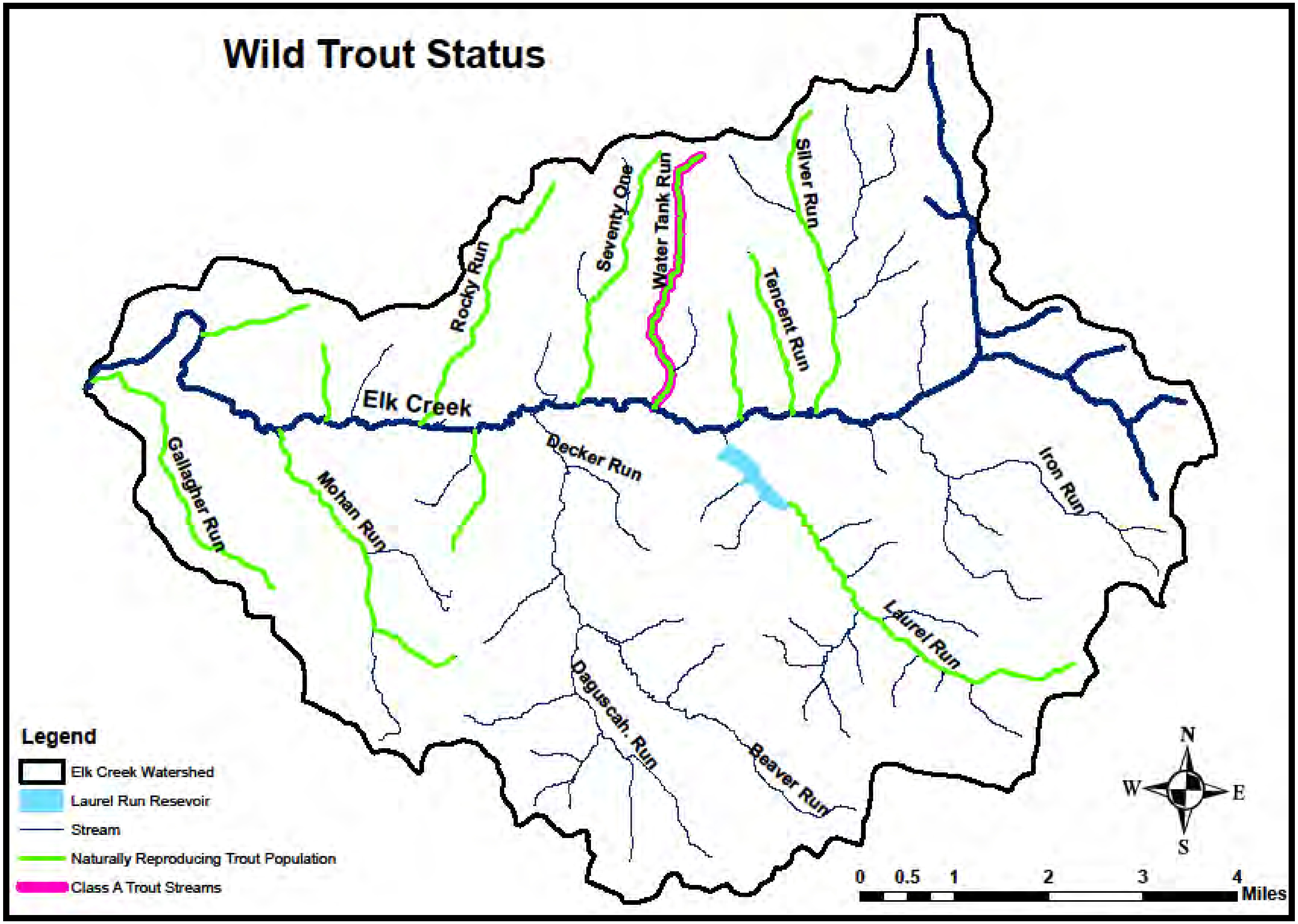


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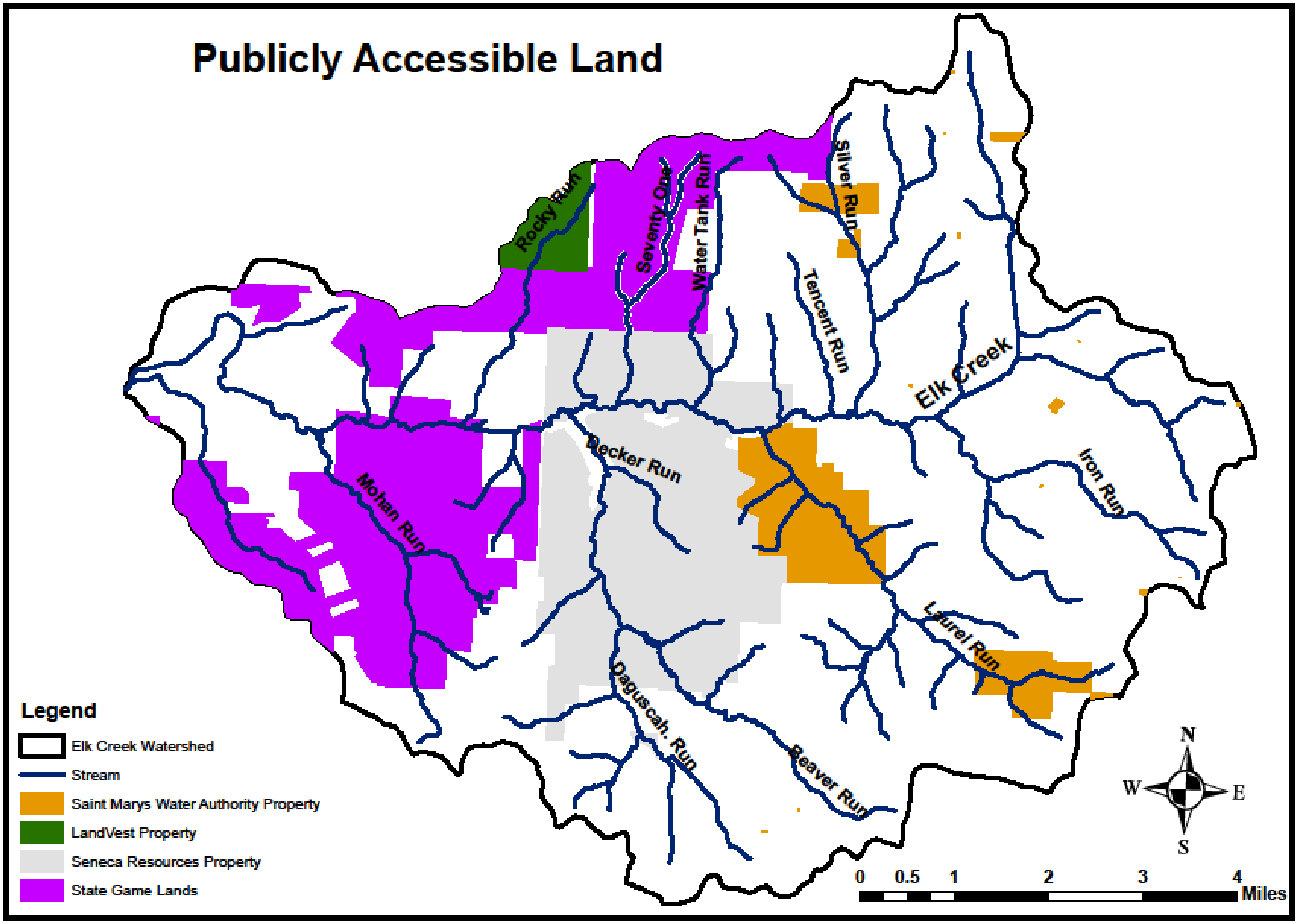


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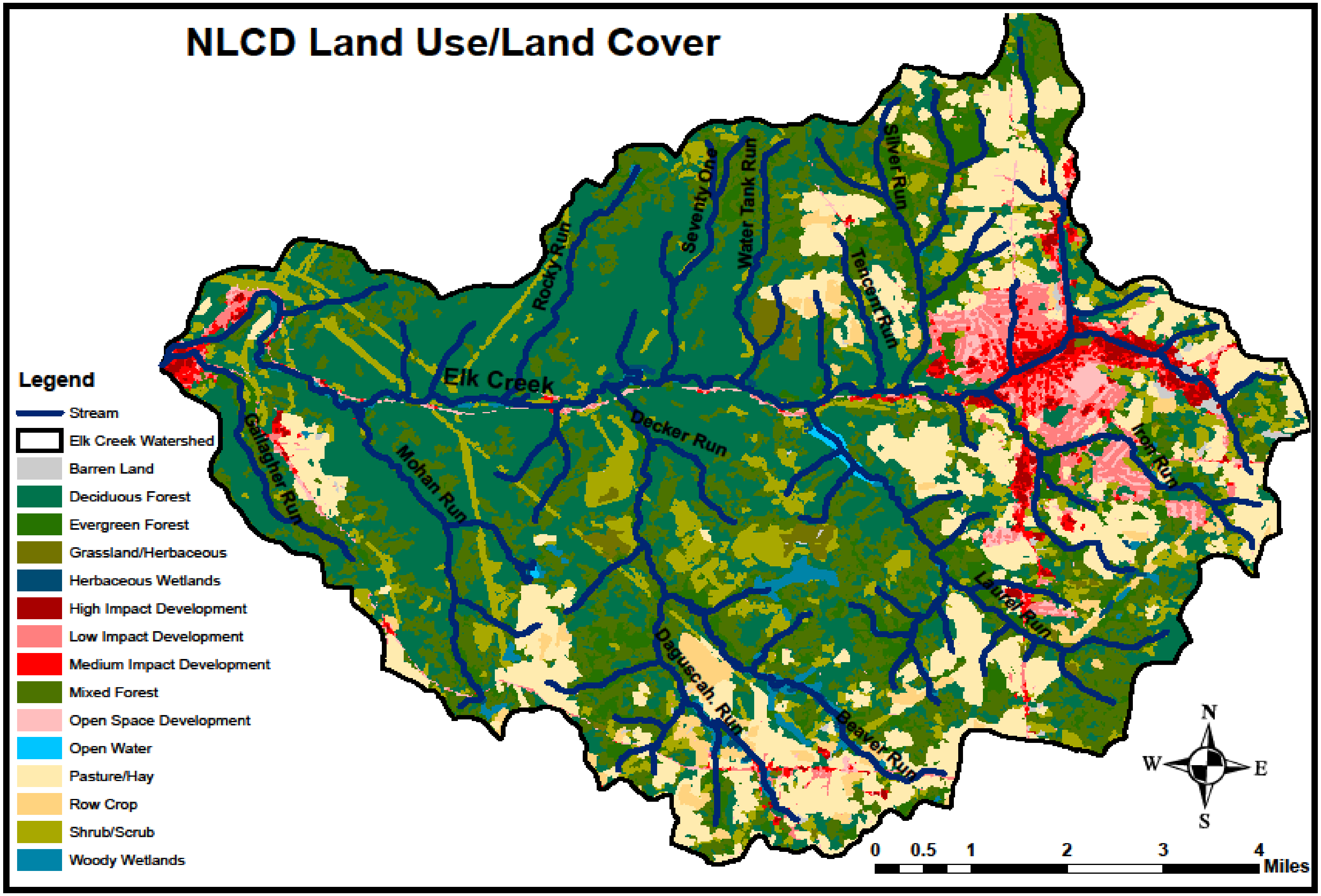


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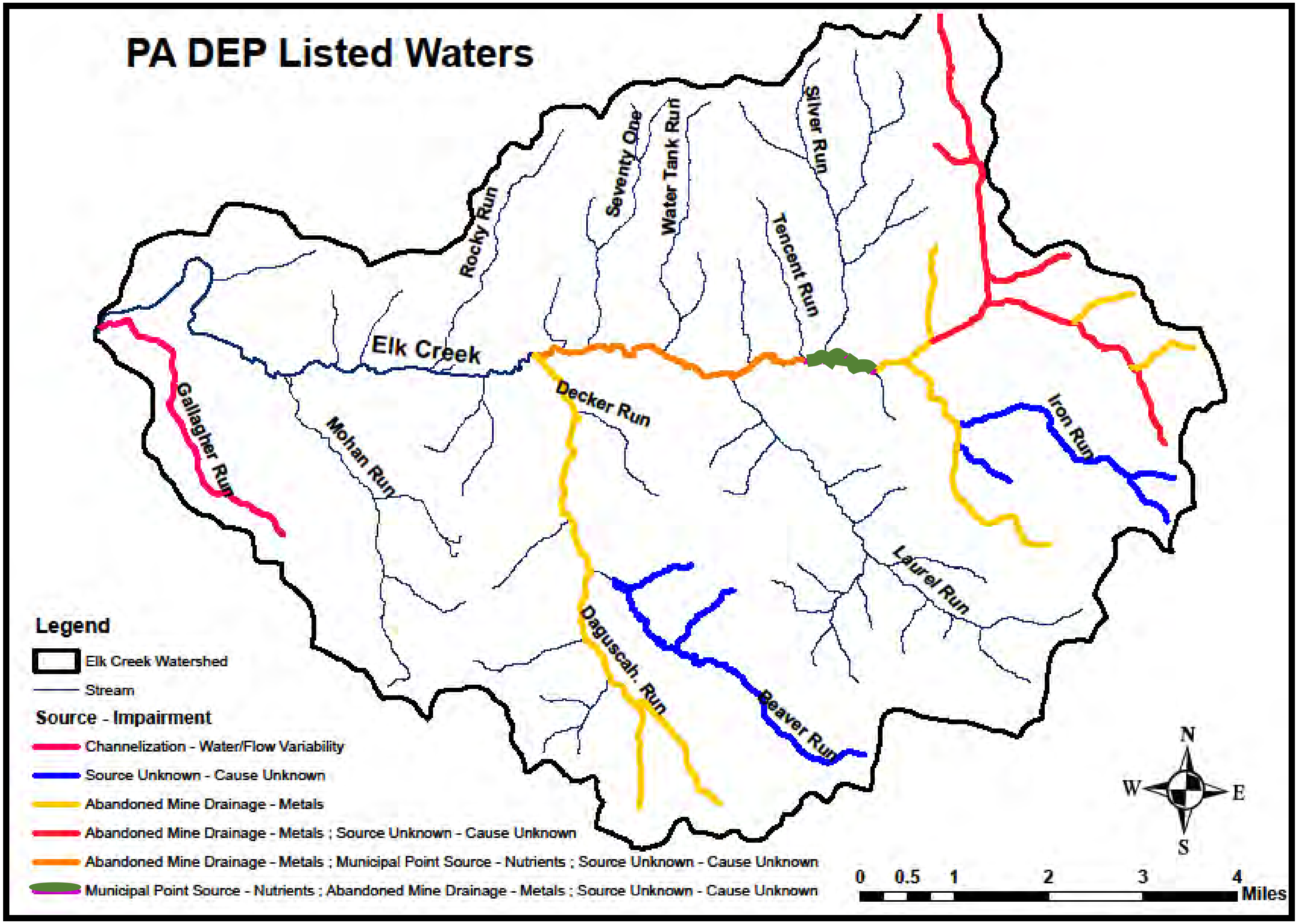


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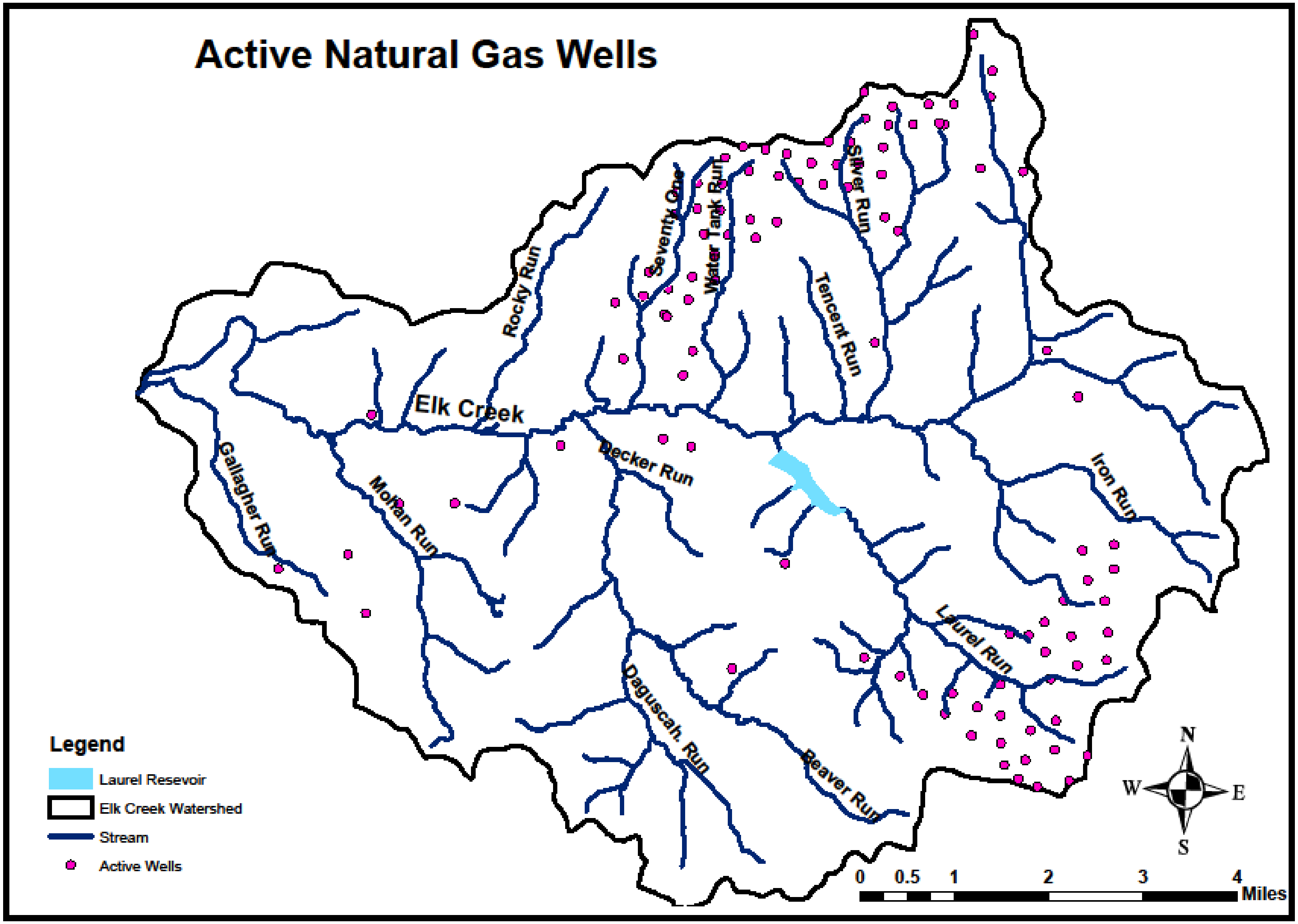


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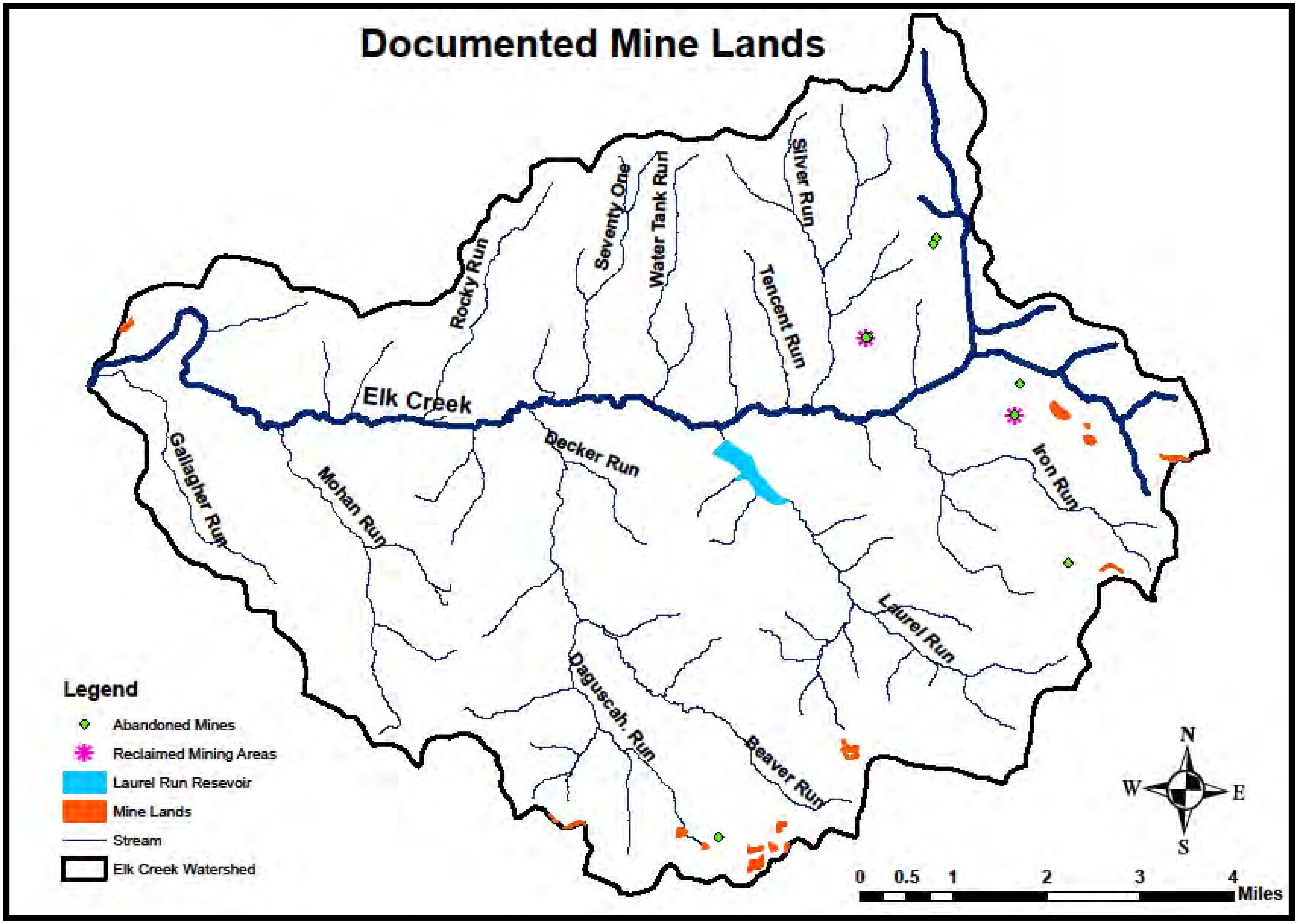


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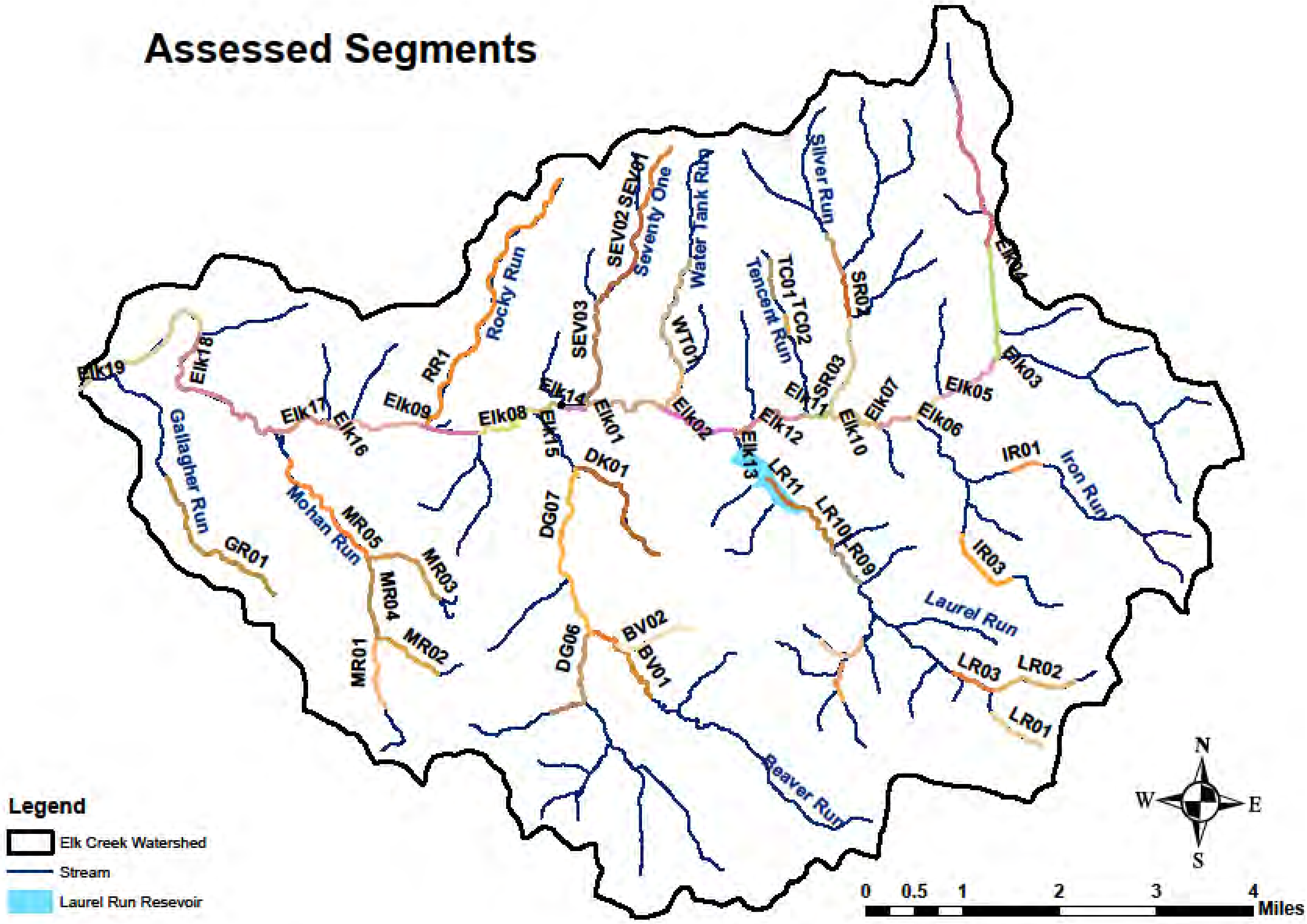


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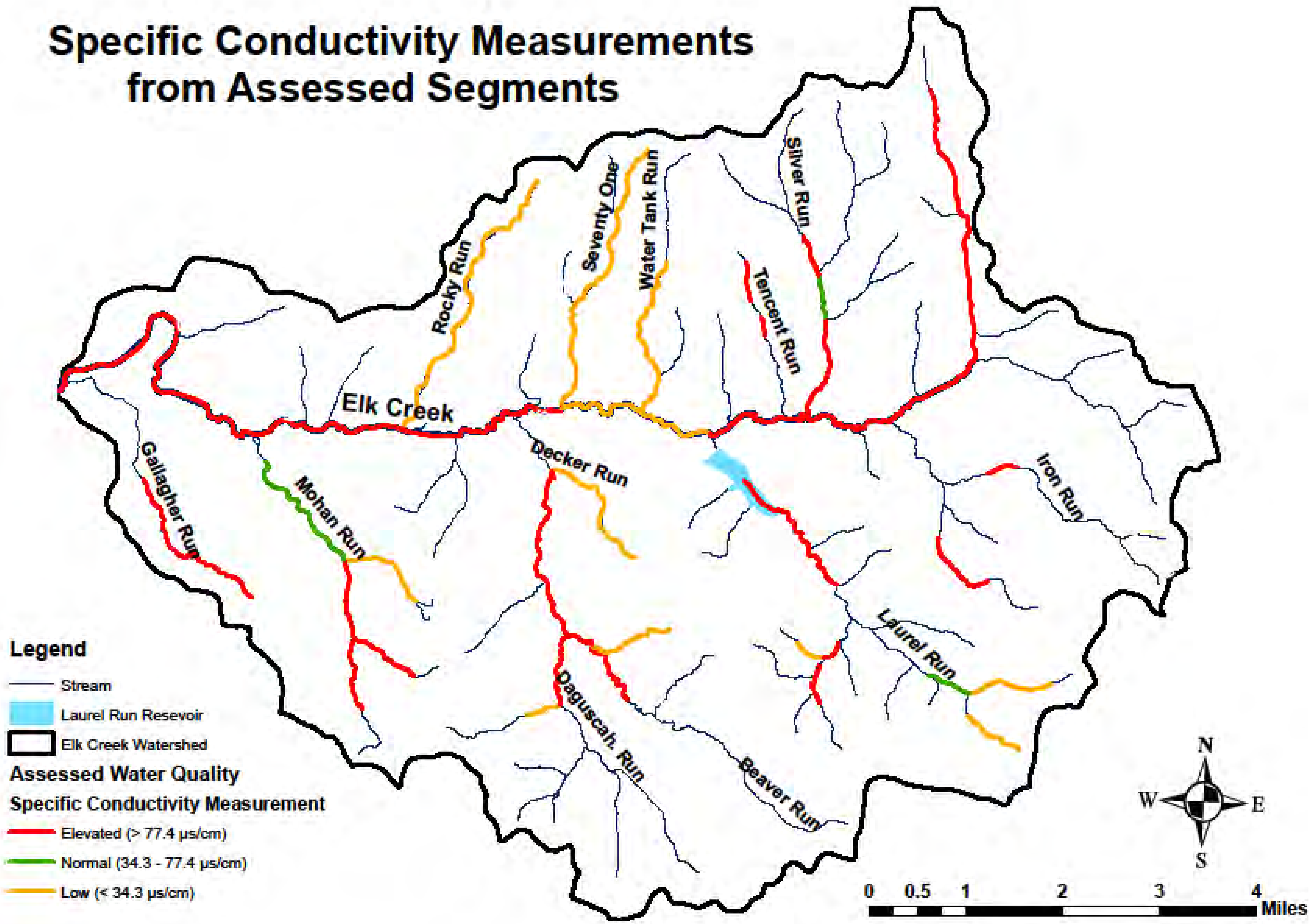


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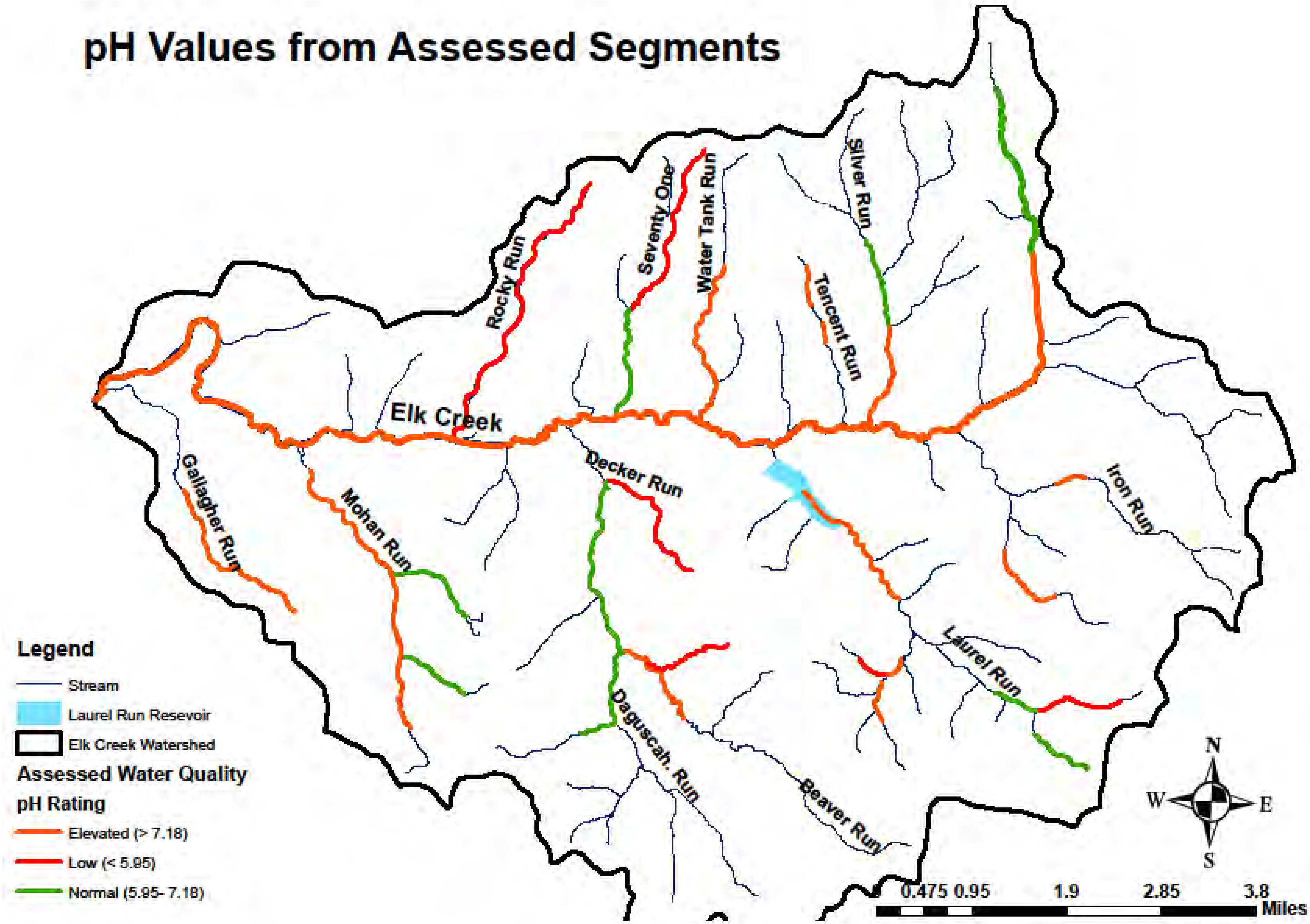


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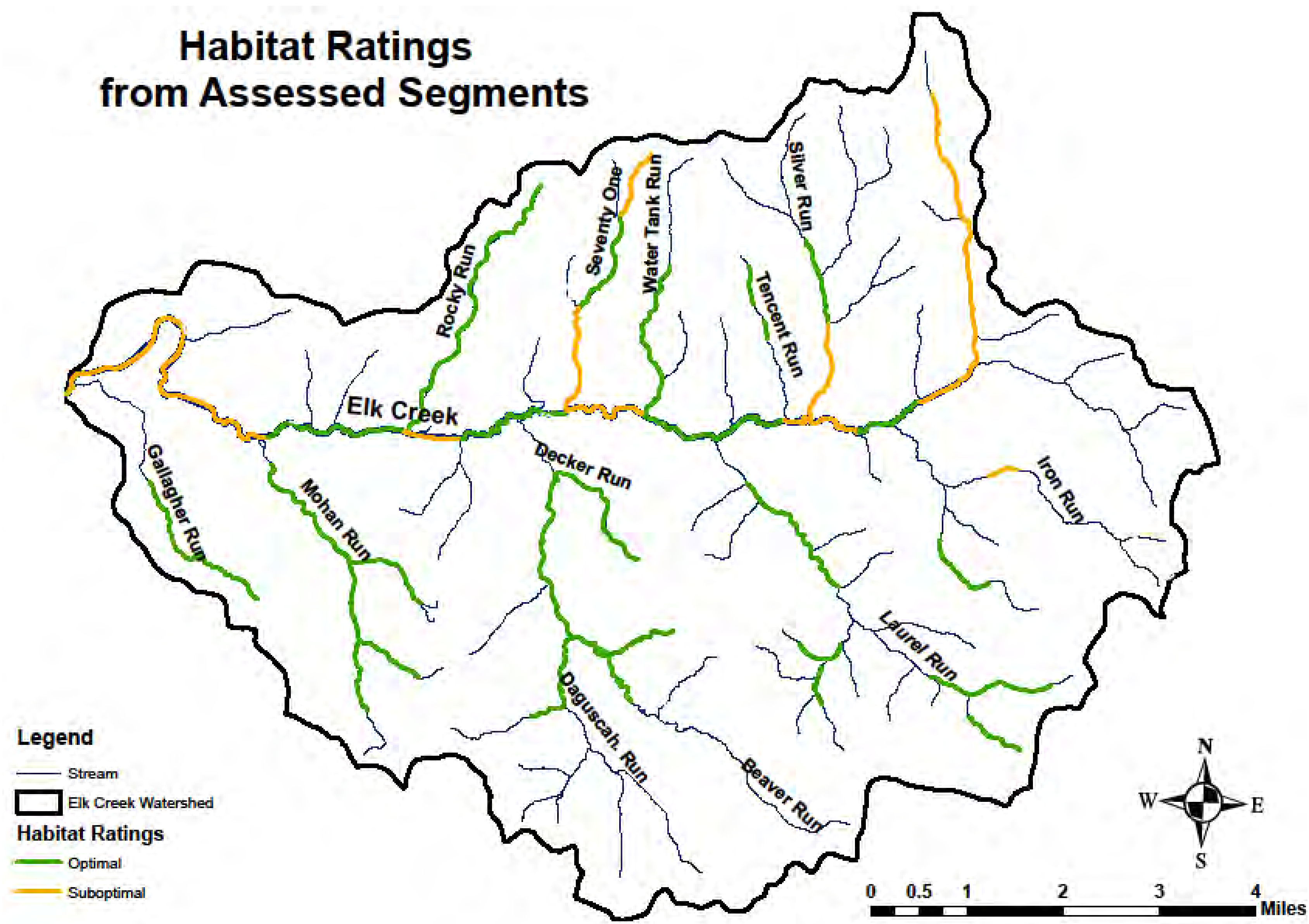


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## Introduction

Elk Creek drains 63.5 $mi^2$ of land, including the City of St. Marys and a portion of Ridgway in Central Elk County, PA (Figure 1). Elk Creek flows 16.4 miles from its headwaters, North of St. Marys, until its confluence with the Clarion River in Ridgway. Elk Creek and its tributaries have Chapter 93 Coldwater Fishery designation by the Pennsylvania Department of Environmental Protection (DEP). Seven Elk Creek tributaries, which account for over 25% (46.2 mi) of the stream miles within the watershed, harbor naturally-reproducing trout populations (Figure 2). One of the tributaries, Water Tank Run, is also designated as a Class A trout stream by the Pennsylvania Fish and Boat Commission. Though the main stem of Elk Creek does not have naturally-reproducing trout populations, Elk Creek is critical in connecting trout populations between tributaries.

The Elk Creek watershed has many opportunities for recreation. State Game Lands 25 and 44 are located in the western portion of the watershed, making 30.1% of the stream miles within the watershed publicly accessible (Figure 3). Private natural resource companies also provide public access to other areas of the watershed. Seneca Resources owns 8.1 $mi^2$ encompassing the lower reaches of Daguscahonda, Beaver, Seventy One, and Water Tank Runs, as well as most of Decker Run. LandVest owns the headwaters and the first 1.25 miles of Rocky Run before it enters private property. The watershed contains 7 municipal parks, 3 of which provide access to streams. Iron Run flows through Benzinger Park in Saint Marys, Gallagher Run flows by the Lyle G. Hall Community Pool in Ridgway, and the headwaters of Elk Creek in Saint Marys flow through Kaulmont Park. The Saint Marys Water Authority owns a large portion of the Laurel Run Watershed and allows public access to the stream and the reservoir for fishing.

Although land cover in the watershed is predominantly forested (65.8%), with deciduous trees accounting for the majority of the species composition (Homer, Fry, & Barnes, 2012), trout populations in the Elk Creek drainage face considerable threats from land modifications. Agriculture is the largest land use within the watershed. Pasture and hay fields make up the majority of the agricultural land and account for nearly 12% of the watershed area (Figure 4). The majority of development in the watershed is low-intensity and open residential space, which together account for 9% of the total watershed area. Areas in which development occurs in close proximity to the stream channel can increase the risk of flooding and water quality impairment (Tran, Bode, Smith, & Kleppel, 2010). One example of the effects of encroaching development is present in a tributary to Elk Creek, Gallagher Run. Gallagher Run is on DEP's Integrated List due to channelization, a product of urban development, which causes water and flow variability to impact aquatic life (Figure 5).

Both agriculture and urbanization have the potential to impact water quality, biological communities, and stream habitat integrity by contributing stress in the form of excess sediment, nutrients, toxins, and pathogens (United States Environmental Protection Agency, 2016). Some segments of Elk Creek are on DEP's Integrated List due to nutrient pollution (Figure 5). Common urban stressors, such as runoff from impervious surfaces, direct stormwater input, outdated stormwater infrastructure, and stream burial are also present within the watershed. Elk Creek is buried and flows underground for 0.18 mi from Depot Street before it daylights again at the intersection of State Street and Highway 120 in St. Marys. Stormwater infrastructure is outdated or nonexistent in St. Marys because development projects prior to 2010 were not required to comply with stormwater ordinances. Lack of and/or insufficient stormwater controls create flooding issues throughout the watershed. Elk Creek is maintained by dredging, removing woody debris, and mowing riparian vegetation from the Penn Dot building on Front Street until the confluence with the Clarion River to mitigate flooding in downtown Ridgway. Though stream maintenance could lessen the impacts and frequency of flood events, it negatively alters stream habitat and can result in degraded water quality and decreased ecosystem function (Bernhardt, Band, Walsh, & Berke, 2008). Large woody debris or material is beneficial by providing fish habitat, enhancing stream stability and adding biodiversity.

Resource extraction presents additional threats to Elk Creek. Natural gas and coal extraction within the Elk Creek drainage was, and continues to be, extensive. Elk Creek Watershed contains 104 active conventional natural gas wells (Pennsylvania Department of Environmental Protection, 2013) (Figure 6).Wells in good, working order do not cause impacts to streams, but access roads and well pads can cause stream habitat degradation through sedimentation and physical alterations to stream channels (Entrekin, Evans-White, Johnson, & Hagenbuch, 2011). The Pennsylvania Department of Environmental Protection reports 8 abandoned coal mines within the Elk Creek watershed (Figure 7). Of the 8 mines reported, acid mine drainage was noted at six of the mines and found to have infiltrated groundwater at two mine sites (Pennsylvania Department of Environmental Protection, 2019).Abandoned mine drainage frequently contributes to declines in pH and increases in dissolved metal (e.g. Fe, Al) concentrations, both of which are stressors to aquatic organisms (Hogsden & Harding, 2012). According to the DEP, Elk Creek is listed as impaired for aquatic life use due to AMD: Metals from its origin north of Saint Marys until its confluence with Daguscahonda Run. The tributaries Iron Run, Beaver Run, and Daguscahonda Run are also listed as impaired from metal contamination due to abandoned mine drainage.

Knowing the existing impacts and potential threats to Elk Creek, the goal of the Elk Creek Coldwater Conservation Plan is to identify specific threats to chemical, physical, and biological integrity and to recommend conservation and restoration strategies to protect Elk Creek's status as a coldwater fishery. The conservation strategies outlined in this plan are only recommendations and opportunities to improve ecosystem health in Elk Creek and do not obligate landowners or organizations to complete the recommended projects.

## Methods

### Instream Habitat

We assessed stream habitat quality of Elk Creek and 10 of its major tributaries in segments using qualitative metrics created by the PA Department of Environmental Protection (DEP) from June through August 2018. Stream segments consisted of portions of streams between confluences (Figure 8). Each segment received an overall habitat score of optimal, suboptimal, marginal, or poor based upon the following physical characteristics:  substrate quality, streambank condition, water velocity/depth, embeddedness, flow status, bank vegetative protection, and riparian zone width**.** Habitat assessments were completed during each assessment walking along the stream and were completed by August of 2018. Within each segment, all barriers to aquatic organism passage and human impacts to the stream channel were documented. We collected temperature, specific conductivity, and pH once at the beginning and end of each segment with an Oakton PCSTestr 35 Multi-Parameter multi-meter. In areas where acid mine seeps were observed, we collected additional specific conductivity and pH samples from the seeps. We noted the presence/absence of native and wild trout and other fish species within each segment.

**Nutrient and Sediment Loadings**

Model My Watershed was used to model nitrogen, phosphorus, and sediment loadings throughout the watershed. Model My Watershed is an application within WikiWatershed, which is a professional grade web application developed by the Stroud Water Research Center that uses land use and soil data to help users estimate water quality impacts within watersheds. We began by delineating each tributary within Model My Watershed and extracting land use, soil, and climate characteristics. We then inserted the data into the Model My Watershed WikiWatershed Spreadsheet Tool and calculated nitrogen, phosphorus, and sediment loadings from land use and land cover within the watersheds. To calculate loadings for the main stem of Elk Creek, we delineated the entire Elk Creek watershed and used the WikiWatershed Spreadsheet Tool to calculate loadings. We then substracted the sum of the loadings from all the tributaries from the Elk Creek loadings. Using this method, it is important to note that Elk Creek loading rates contain data from the smaller, unnamed tributaries throughout the watershed which were not assessed in this study.

## Section 3. Elk Creek Main Stem Summary

Elk Creek begins in North Saint Marys and flows south along Windfall Road where it becomes a 2nd order stream just before it crosses under Washington Street at Saint Marys Auto Repair. This segment of Elk Creek, EC04 (Photo 1), was about 6ft wide and had a mostly-forested riparian area. Instream fish habitat was mostly pool and riffle and the substrate was predominantly cobble and gravel. Many wild trout were observed throughout this segment. Elk Creek enters a wetland just before it crosses under Washington Street at the beginning of segment EC03 (Photo 9). Substrate size is smaller, pool habitat becomes more dominant, and the water has an orange coloration after it leaves the wetland. The stream follows a retired railroad bed and enters another wetland just south of the Elk County Community Recycling Center. This segment of Elk Creek along Washington Street is over-widened and has many shallow riffles due to being previously straightened for the installation of the railroad.

Elk Creek remains a 2nd order stream as it flows along the east side of Washington Street until it meets its 2nd order eastern headwater branch at the former Stackpole-Hall Complex. At this point, the beginning of segment EC05 (Photo 21), Elk Creek becomes a 3rd order stream. The stream health begins to decline in EC05. The stream is channelized, warm in temperature, and has orange water with a chemical odor throughout this segment. There is very little cover available for aquatic organisms and much of the streambank is reinforced with walls or riprap. Two buildings in this segment are positioned so close to Elk Creek that their foundations line the streambank or are undercut by the stream. EC05 flows underground at Sheetz, daylights at Don's Pizza, and ends just after the bridge on McGill Street (Photo 25, 29). Specific conductivity was elevated and increased from 531 to 538 µs/cm by the end of EC05 (Photo 30).

Segment EC06 is composed of uncharacteristically large substrate compared to the rest of Elk Creek. The channel was mostly boulder (45%). A lot of the boulders were former fill material, which was likely once used for riprap bank stabilization and eroded into the channel. EC06 serves as a transport segment of Elk Creek, where material sourced upstream, and from this segment, flows through this segment and is deposited downstream in segment EC07. A high, eroding bank behind the Windfall Carwash is evidence of storm water flow velocity and the transport capability of EC06 (Photo 32).

Elk Creek becomes a 4th order stream at its confluence with Iron Run near Keystone Powdered Metal (Photo 35). This segment of Elk Creek, EC07, is a depositional stretch of channel and substrate is significantly smaller than the section immediately upstream. Many gravel bars in this segment are newly-formed/recently expanded and the substrate is moderately embedded. Water clarity improved in EC07 and was less turbid. Instream habitat consisted of only a few undercut banks and was rated as suboptimal; however, trout, dace, and darters were observed in this segment despite the lack of habitat. Specific conductivity improved to 476 µs/cm at the bottom of EC07, likely due to dilution; however, this value is elevated for the EcoRegion.

Segment EC10 (Photo 41), immediately downstream of EC07, had suboptimal instream habitat. Habitat within the stream channel alternated between riffles, comprised primarily of cobble, and depositional areas which consisted of mostly silt and sand. Many of the cobbles were covered in filamentous algae throughout EC10 (Photo 42, 43). Specific conductivity increased to 604 µs/cm and pH increased to 8.8 by the bottom of the segment. Filamentous algae and elevated water quality parameters are symptoms of the nutrient pollution from the St. Marys Sewage Treatment Plant which discharges into this segment. Silver Run confluences with EC10 to start segment EC11.

Overall, EC11 habitat was in suboptimal condition. Specific conductivity and pH remained elevated at 540 µs/cm and 8.9, respectively. Substrate is just as embedded as it was the immediate upstream segment with cobbles and boulders covered by silt. EC11 has a variety of riffle, run, and pool habitat available; however, these habitats are poor quality because they lack cover for aquatic organisms. EC11 ends, and EC12 begins, where Tencent Run confluences with Elk Creek (Photo 55). Fish habitat begins to improve in EC12; however, substrate was embedded similar to upstream sections. EC12 had excellent cover in the form of large woody debris (Photo 56). The streambanks were moderately stable throughout this section and the majority of streambank erosion occurred where the powerline right of way crosses Elk Creek (Photo 63). Specific conductivity values were similar to values from immediate upstream segments; however, pH was elevated to 9.3 at the bottom of the segment. EC12 ends upstream of the Saint Marys Water Authority at the confluence of Elk Creek and an unnamed tributary from the North.

EC13 is a moderately stable segment of Elk Creek with suboptimal aquatic organism substrate and cover. Specific conductivity is lower in this segment compared to the segment immediately upstream. Specific conductivity decreased to 507 µs/cm by the end of this segment; however, this value is much higher than baseline conditions for the EcoRegion. pH was also elevated at 9.4 at the end of the segment. The majority of the streambank erosion in this segment is concentrated in the portion of the stream channel where the powerline crosses back over Elk Creek. There were two very large gravel bars in EC13 which were recently expanded and the pools adjacent to the gravel bars were moderately embedded. Despite a large portion of EC13 being a depositional area, there was little retention of woody debris. EC13 ends at the confluence of Elk Creek and Laurel Run, where EC02 begins (Photo 68).

EC02 exhibited an improvement in water quality, but had similar habitat quality compared to segments immediately upstream. pH and specific conductivity improved to 8.1 and 32.2 µs/cm, respectively, by the end of the segment. The improvement in water quality could be due to dilution from Laurel Run. Laurel Run flows into a reservoir before entering Elk Creek, providing an opportunity for particles to settle and nutrient uptake to occur before entering Elk Creek. Like the immediately upstream segments, EC02 was moderately embedded, eroded, and lacked woody debris. The largest eroded streambank was adjacent to the railroad. The most notable change to instream habitat in this segment was a run containing exposed boulder clusters (Photo 75). The exposed boulder clusters provided flow variability and cover which were not present in segments immediately upstream. EC02 ends at the confluence of Elk Creek and Water Tank Run, where EC01 begins (Photo 72).

EC01 is the segment of Elk Creek which connects Water Tank and Seventy One Runs. pH values again increased to 8.3 by the end of this segment, though specific conductivity values were similar to the immediately upstream segment (EC02). EC01 contained a lot of streambank erosion and sedimentation. The streambanks were composed of fine soils and were, thus, very naturally erodible. Maintenance of the riparian vegetation where the powerline crosses and runs parallel to EC01 greatly contributed to the erosion in this segment (Photo 81). The only large woody debris in this segment was a tree which had slumped into the channel due to erosion (Photo 80). More woody debris was present on a large gravel bar; however, it did not provide overhanging cover or instream habitat at normal flow.

Segment EC14 beings immediately downstream of EC01, where Elk Creek and Seventy One Run confluence (Photo 82). EC14 is a short stretch of stream, and has moderately-eroded streambanks. pH values in this segment are similar to upstream values; however, Specific conductivity increases to from 27.5 µs/cm at the end of EC01 to 414 µs/cm by the end of EC14. The cause of the spike in specific conductivity is hard to pinpoint. Land cover immediately surrounding EC14 is predominantly forested and water entering EC14 from Seventy One Run had low specific conductivity, so point sources of water with elevated specific conductivity were unable to be located. Suspended particles sourced from the erosion of the powerline right-of-way in EC01 and in this segment could be a cause of elevated specific conductivity (Photo 87). Herbicides used to maintain the vegetation in the powerline could be adsorbed to surrounding soil particles. As streambank surrounding the powerline erodes, chemicals could dissociate from soil particles and become dissolved in water to increase specific conductivity. Specific conductivity and pH remain elevated as EC14 flows into EC15 an unnamed tributary from the North. Instream cover and embeddedness improve in EC15, though the streambanks remain moderately eroded in this segment. Many of the pools within EC15 contained large woody debris and overhanging riparian vegetation (Photo 89).

EC15 ends at the confluence of Elk Creek and Daguscahonda Run, where EC08 begins (Photo 95). pH in EC08 is elevated similar to the immediate upstream segment of Elk Creek, but specific conductivity improves to 249 µs/cm by the end of the segment. Streambanks are more stable in this segment, but cover and instream habitat are not as excellent as the immediate upstream segment (EC15). EC08 lacks overhead cover in the form of large woody debris, overhanging riparian vegetation, and exposed boulders. Overhanging vegetation is lacking because large sections of streambank abut Highway 120, the railroad (Photo 96), residential lawns (Photo 97), and the powerline right-of-way. The section of EC08 which flows adjacent to Highway 120 was stabilized with riprap and had very little riparian vegetation (Photo 98).

EC09 begins at the confluence of EC08 and an unnamed tributary from the South, just upstream from the Store at Daguscahonda (Photo 99). EC09 had minimal large woody debris, no undercut streambanks, few exposed boulders, and many pools with no overhead cover. Substrate was moderately embedded and many sections of EC09 were silted. Pools were the most dominant habitat type in EC09, which helps to explain the sediment deposition observed during assessment. Water quality parameters did not improve or decline compared to the immediate upstream segment (EC08). EC09 ends at the confluence of Elk Creek and Rocky Run, where EC16 begins (Photo 107).

EC16 was a transporting segment of Elk Creek and thus had fewer sediment depositional areas and sedimentation compared to the segment immediately upstream (EC08). Riffle habitat was equally as prevalent as pool habitat in EC16. Faster, more shallow segments of the stream helped to transport sediment downstream and preserved the interstitial spaces between substrate, but appeared to cause increased streambank instability. EC16 had a moderate amount of large woody debris present in the stream channel, but apart from one riffle composed of large, exposed boulders (Photo 111), lacked boulder-sized substrate to create habitat variability and overhead cover. pH and specific conductivity were both elevated and increased to 9.4 and 327 µs/cm, respectively, by the end of EC16.

EC17 begins immediately downstream from EC16, where EC16 confluences with an unnamed tributary from the North (Photo 116), and ends at the confluence with Mohan Run (Photo 123). Water quality parameters in EC17 were similar, but instream habitat was degraded in comparison to the segment immediately upstream. Apart from one log jam, EC17 lacked cover and suitable substrate for aquatic organisms. EC17 lacked boulders to provide cover and flow variability for aquatic organisms. Though streambanks were slightly eroded, undercut streambanks were absent.  Pool habitats, in particular, were long and had poor cover.

EC18 is immediately downstream of EC17 and begins at the confluence of Mohan Run of Elk Creek. EC18 instream habitat was similar to the section immediately upstream, lacking undercut banks, large woody debris, and overhead cover. EC18 has moderate channel alteration and has many sections which are straightened and many banks which are armored due to Elk Creek bouncing back and forth from Highway 120 and the railroad (Photo 129, 130). Water quality parameters remained similar to immediately upstream sections. EC18 ends at the confluence with an unnamed tributary from the north, where EC19 begins (Photo 137). EC19 is the most downstream segment of Elk Creek which confluences with the Clarion River behind the Country Squirrel Outfitters in Ridgway (Photo 151). Fish habitat begins to improve at the beginning of EC19, but quickly declines soon after it crosses under the Depot Street Bridge in Ridgway Borough.  Surrounding the bridge, EC19 had flow variability, overhanging riparian vegetation, exposed boulders, and little embeddedness. Downstream of the Depot Street Bridge, Elk Creek transitions to a bedrock bottom which does not retain variably-sized substrate or large woody debris. Instream habitat then improves as the bedrock bottom transitions back to cobble/boulder substrate just upstream of the PennDot building (Photo 140). After the PennDot building, EC19 had the most degraded aquatic organism habitat of any segment of Elk Creek.  From the Penn Dot building until the confluence with the Clarion River, Elk Creek is maintained to control flooding. The maintenance includes dredging, gravel bar and woody debris removal, bank revetments, and rip-rap (Photo 144-146). EC19 lacks substrate size variation, overhead cover, large woody debris, and undercut streambanks until its confluence with the Clarion River.

**Fish Status**

Wild trout were observed in two segments of Elk Creek, EC3 and EC4, which are north of St. Marys. EC3 and EC4 are forested, headwater segments of Elk Creek. A variety of other native fish species were observed in segments EC5, 6, 10, 2, 8, and 9. Species observed were the white sucker, blacknose dace, creek chub, and greenside darter. There were no fish sightings in the remaining segments of Elk Creek, though, that does not mean fish were absent from these segments. Rainbow trout were observed in EC02 upstream of Water Tank Run. The majority of native trout observed throughout assessment were located in tributaries to Elk Creek.

**Threats**

The largest threat to Elk Creek is degraded water quality. Portions of Elk Creek are on DEP's Integrated List as impaired for aquatic life (Figure 9). Impairment begins in the northern and southern branches of the Elk Creek headwaters, where water is polluted with metals due to acid mine drainage and unknown causes. Unknown sources of metal contamination in Elk Creek could be due to the powdered metal industry in the region. It is possible that some metals may remain dissolved in solution post water treatment and are discharged into Elk Creek. Elk Creek remains impaired due to excess metal concentrations until its confluence with Daguscahonda Run. Downstream of the Saint Marys Sewage Treatment Plant (STP), Elk Creek is nutrient-impaired due to STP discharge until its confluence with Tencent Run. Additional segments of Elk Creek are impaired for aquatic life due to unknown reasons and sources.

Specific conductivity were elevated along Elk Creek during assessment (Figure 8). Typical range for specific conductivity is 12 – 71 µs/cm in the North Central Appalachians (Griffith, 2014), but Elk Creek specific conductivity values were rarely within normal range during assessment. Specific conductivity measures the capability of a solution to pass an electrical current, so specific conductivity increases as dissolved ion concentration increases. Common examples of ions dissolved in polluted streams include nutrients, salts, or metals. Elevated specific conductivity can cause osmotic stress in aquatic organisms, making it harder for species to secure the resources they need for growth. Growth and feeding alterations can ultimately have trickle-down ecosystem effects and can alter ecosystem functions, like nutrient uptake.

pH was elevated the entire length of Elk Creek with the exception of a small section of the northern headwaters (Figure 9). Typical pH values for the North Central Appalachians range between 5.95 and 7.18 (Griffith, 2014). Elk Creek pH values ranged between 7.1 and 9.4. pH values elevated above 8.5 were particularly concerning as water at those pH values can begin to impact aquatic life. In the field, the source of pollutants contributing to elevated pH readings was not immediately clear. Instrument error cannot be ruled out.

Urban development is a threat to habitat integrity and water quality in Elk Creek (Figures 4, 10). Due to impervious surface and urban development in St. Marys, water storage in upper Elk Creek is poor. The majority of stormwater in upper Elk Creek runs off impervious surface instead of infiltrating natural landscapes. Not only does impervious surface create increased volumes of stormwater, but it contributes to water pollution. Vegetation, bacteria, and soils in natural landscapes can uptake, immobilize, or absorb, pollutants and nutrients in stormwater. Additionally, portions of Elk Creek are channelized, flow underground, and are disconnected from the floodplain. Direct alterations to the stream channel cause constriction and further impact the amount of stormwater retention possible in upper Elk Creek (Walsh et al., 2005). Water travels at a greater velocity and has a greater capacity to cause streambank erosion. Faster flowing water through altered segments exacerbates flooding downstream. Stormwater strips the stream channel of substrate and woody material which provide habitat and food for aquatic organisms.

Development proximity to Elk Creek presents additional threats to instream habitat (Figure 4). Elk Creek is crossed by a powerline right-of-way, railroad, and Highway 120 numerous times as it flows towards the Clarion River. The powerline right-of-way vegetation is maintained by herbicide and cutting. Erosion is exacerbated by the lack of riparian vegetation species and trees in powerline crossings. Powerline crossings also allow more sunlight to reach the stream channel, creating thermal barriers for coldwater species (Petty, Hansbarger, Huntsman, & Mazik, 2012). The railroad grade and highway disconnect Elk Creek from its floodplain in numerous areas. As mentioned previously, floodplain disconnection constricts the stream channel and causes water to flow at higher velocities. Higher velocity flows have caused streambank erosion in many of the areas where the highway and the railroad lie immediately beside the stream.

**Recommendations**

Addressing elevated pH and specific conductivity values within Elk Creek will require further investigation to determine the nature and source of pollutants contributing to elevated readings. Elk County Conservation District should install water quality monitors throughout Elk Creek to gather continuous water quality data. Based on data from continuous observation, effort can be concentrated to investigate segments of Elk Creek with degraded water quality. Eliminating Elk Creek water quality stressors cannot be accomplished without also addressing water quality stressors from tributaries, as well.

Resolving the nutrient impairment from point sources will involve placing Total Maximum Daily Load requirements on Elk Creek. Currently, the Saint Marys Sewage Treatment Plant is required to monitor the total nitrogen and total phosphorus concentrations in effluent discharged to Elk Creek. The plant does not currently possess the infrastructure necessary to uptake nutrients from wastewater or discharge a certain concentration of nutrients to receiving streams. Reducing nutrient concentrations in Elk Creek will also help lower specific conductivity values downstream from the plant.

Elk Creek water quality and instream habitat would benefit from stormwater catch basin construction, floodplain reconnection, and minimizing the development of new impervious surfaces in the upper watershed. Businesses, homes, highways, railroads, and powerlines would ideally be located outside of the floodplain; however, relocating development is not a feasible option. Realistically, new development in the Elk Creek floodplain should be discouraged to protect people, infrastructure, and the stream. Installing stormwater catch basins in upper Elk Creek throughout St. Marys could alleviate flood issues downstream and improve water quality.

Stormwater basin construction faces many challenges which may make the practice unfeasible. Funding and land to construct stormwater basins may be difficult to secure. Smaller, instream habitat restoration projects along Elk Creek are likely to be more practical.

Though habitat restoration projects may not address the source of water quality and habitat stressors, projects can improve local streambank stability, habitat, and water quality. Fish and Boat approved habitat structures which prevent streambank erosion, such as root wad deflectors, mudsills, or log vanes, should be utilized in eroding areas where the railroad and highway are close to Elk Creek. Utilizing deflectors, mudsills, and root wads, in lieu of traditional methods of bank stabilization (ex., riprap, concrete, or gabion baskets) will provide excellent aquatic organism habitat in addition to protecting streambanks. In areas of Elk Creek where logs and root wads can be harvested locally, installing habitat structures could be more cost effective than using traditional methods of bank stabilization. Habitat structures also have lower permitting costs and greater longevity compared to traditional bank stabilization methods.

## Elk Creek Photos

Photo 1. Beginning of EC04 looking upstream. EC04 is the northern headwaters of Elk Creek and located before Elk Creek flows into the City of Saint Marys.

Photo 2. Culvert outlet under an ATV trail in EC04. Wild Brook Trout were observed in the tail pool. At normal and low flows, this culvert presents challenges for aquatic organism passage.

Photo 3. Trout habitat in the form of an undercut bank, flow variability, and exposed root and cobbles in EC04.

Photo 4. Woody debris jam habitat in EC04.

Photo 5. Clogged culvert inlet under a driveway along Windfall Road in EC04. Replacing the culvert with a larger structure would allow debris and aquatic organisms to pass through, as well as prevent flood waters from overtopping the driveway.

Photo 6. Section of EC04 with uncharacteristically small substrate which flows through a prairie before reentering the woods.


Photo 7. Culvert outlet under a driveway off of Windfall Road in EC04 with multiple, undersized pipes.

Photo 8. Grass clippings disposed of in the stream channel along EC04. Grass clippings could introduce excess nutrients to the stream and harmful chemicals such as pesticides or herbicides.

Photo 9. Wetland near St. Marys Auto Repair in EC04. Elk Creek becomes a lower-gradient, slow-flowing stream after it crosses under Windfall Road near Amphenol Sensors then enters a wetland complex (above) across from Windfall Car Wash. EC04 continues through a wetland until the crossing under Weidow Crest Road.

Photo 10. End of segment EC04 behind Pesce Metal Fabrication on Washington Street.

Photo 11. Beginning of EC03 upstream of the Conservation District office on Washington Street.

Photo 12. Eroded left bank in EC03.

Photo 13. A shallow, over-widened section of EC03. Habitat in this section could be improved through the use of large woody debris addition or habitat structures to create flow and substrate homogeneity.

Photo 14. A relic beaver dam in EC03 behind the Nittany Mini Mart on Washington Street. EC03 is a wetland stream beginning downstream from the Conservation District until the culvert under Prechtl Lane.

Photo 15. Drain from a residential area between the Nittany Mini Mart and the Conservation District on Washington Street. Specific conductivity near the drain was 579 µS/cm, which could indicate possible organic pollution.

Photo 16. Culvert under Prechtl Lane off of Washington Street. Though water in the pipe closest to the right bank was orange, the coloration appeared to be natural from bacteria.

Photo 17. A drain near Enhanced Sintered Products discharging red water into EC03. Specific conductivity of the discharged water was elevated at 300 µS/cm.

Photo 18. Fill along the streambank near Enhanced Sintered Products in EC03. The fill does not allow vegetation to grow along the streambank and could contribute to increased rates of erosion as well as warmer water temperatures due to the lack of overhanging vegetation.

Photo 19. Storm drain beneath Enhanced Sintered Products which outlets into segment EC03. Specific Conductivity of water from the storm drain was 370 µS/cm, which was greater than the specific conductivity of Elk Creek upstream (304 µS/cm).

Photo 20. End of EC03 looking downstream towards the former Stackpole-Hall Complex. Elk Creek begins to enter the more developed portion of Saint Marys in this segment.

Photo 21. Beginning of EC05 at the Enterprise Street crossing in the Stackpole Complex.

Photo 22. EC05 looking downstream through the Stackpole Complex. Elk Creek is confined between a retaining wall and a brick building.

Photo 23.Substrate in EC05 through the Stackpole-Hall Complex with orange residue. This section had a lot of unnatural substrate in the form of bricks and chunks of cement.

Photo 24. Pipeline laying above the streambed in EC05.

Photo 25. Portion of EC05 buried under buildings and parking lots within the Stackpole-Hall Complex.

Photo 26. EC05 daylights behind Keystone Diversified Pipe just downstream of the Stackpole-Hall Complex.

Photo 27. EC05 is no longer confined between walls and buildings downstream of Keystone Diversified Pipe. Water color continues to be discolored and has a chemical odor.

Photo 28. An abandoned building with the foundation undercut by Elk Creek in EC05.

Photo 29. EC05 before it flows subsurface near Sheetz.

Photo 30 Looking upstream from the end of EC05 behind Reeds Custom Woodworking before McGill Street. At this location, Elk Creek begins to assume more normal flow patterns and begins to show variation in substrate size.

Photo 31. Looking downstream from the beginning of segment EC06.

Photo 32. Eroded right streambank in EC06 near the Windfall Car Wash on Highway 120. Log vanes or root wad deflectors could help stabilize and protect this streambank.

Photo 33. The same eroded streambank from photo 32.

Photo 34.  Sewer man hole within segment EC06.

Photo 35. End of segment EC06 looking downstream at the confluence of Elk Creek and Iron Run (left).

Photo 36. Looking upstream at the confluence of EC06 (left) and Iron Run (right) where EC07 begins.

Photo 37. Erosion from stormwater overflow off the Keystone Powdered Metal parking lot in EC07.

Photo 37. Fish habitat in EC07. The undercut bank with overhanging roots, as well as exposed boulders, provide overhead cover and flow variability for aquatic organisms.

Photo 38. Cement reinforced bank surrounding bridge abutments on EC07. The bridge connects construction garages to Highway 120.

Photo 39. Deep, slow-moving section of EC07 above the bridge in photo 38. This section has overhanging vegetation, but could further benefit from instream habitat structures to create flow variability and additional habitat.

Photo 40. End of EC07 where an unnamed tributary confluences. The unnamed tributary drains a small area encompassing a portion of Sugar Hill and West Theresia Road before flowing under Highway 120. The culvert pipe may pose a barrier to aquatic organism passage because the outlet is perched and the pipe has low flow.

Photo 41. Beginning of segment EC10 looking downstream at the bridge that connects the St. Marys Sewage Treatment Plant to Highway 120.

Photo 42. Filamentous algae downstream of the St.Marys Sewage Treatment Plant in EC10. This segment of Elk Creek is on DEP’s integrated list for nutrient pollution.

Photo 43. Algae in segment EC10. The algae was so dense, it formed thick mats which completely covered the stream substrate.

Photo 44. Looking downstream at the rock vane in EC10 downstream of the sewage treatment plant.

Photo 45. Looking upstream at the rock vane from photo 44. The rock vane appears to be manmade or accumulated large material overtime due to a pipeline lying on the stream bottom. No pipes were observed during assessment, however.

Photo 46. Debris jam in EC10. The root wad creates habitat for aquatic organisms, but filamentous algae mats removes potential habitat by covering the substrate.

Photo 47. Debris jam in Ec10. A tree on top of an undercut bank fell into the stream channel and accumulated additional woody debris upstream.

Photo 48. Debris jam in EC10. The debris jam creates a pool and provides overhead cover for aquatic organisms.

Photo 49. Slumping gabion baskets in EC10. Gabion baskets often fail over time and provide no habitat for aquatic organisms. Damaged basket wires can be an injury hazard.

Photo 50. End of EC10 looking downstream at the confluence with Silver Run and a debris jam.

Photo 51. Beginning of EC11 looking upstream at EC10.

Photo 52. Sewer line manhole lid stack in the stream channel. The manhole stack has rerouted stream water in to the left bank to cause erosion. The erosion caused a tree to uproot (yellow circle).

Photo 53. End of EC11 looking upstream at falling trees.

Photo 54. End of EC11 looking downstream. Filamentous algae remains abundant in this segment.

Photo 55. Beginning of EC12 looking upstream at the confluence with EC11 and Tencent Run.

Photo 56. Woody debris in EC12 with Highway 120 in the background.

Photo 57. Looking upstream at the Custom Industrial Processing building within the floodplain of EC12. Restoring trees in the riparian area between the building and the stream channel is encouraged to prevent the parking lot from eventually eroding into the stream channel.

Photo 58. Right bank erosion downstream of Custom Industrial Processing in EC12. This section could benefit from log vane or mudsill habitat projects to enhance habitat and protect the streambank.

Photo 59. Undercut tree roots on EC12 which provide good habitat for aquatic organisms.

Photo 60. Excellent fish habitat section of EC12. This section had large boulders, root wads, and logs in a pool area.

Photo 61. Left  bank erosion in EC12 which could be stabilized by root wad deflectors.

Photo 62. Woody debris jam in EC12.

Photo 63. Left bank erosion in EC12 along the powerline right-of-way. Streambank stabilization projects could help protect the electric poles from eroding into the stream channel.

Photo 64. Beginning of EC13 looking upstream.

Photo 65. Long, deep segment of EC13 that could benefit from habitat improvement projects.

Photo 66. Long, shallow riffle in EC13 that could benefit from random boulder cluster habitat.

Photo 67. Eroding left bank at the confluence of EC13 and Laurel Run.

Photo 68. Beginning of segment EC02 looking upstream at the confluence of EC13 and Laurel Run.

Photo 69. Erosion along the railroad in EC02. Installing streambank stabilization structures would help prevent further erosion.

Photo 70. Tree in segment EC02 which could be winched into the stream channel to provide instream habitat.

Photo 71. Right bank erosion in EC02.

Photo 72. Left bank erosion along the powerline right-of-way in EC02.

Photo 73. Embedded rocks in EC02. Silt and fines covered interstitial spaces and reduced habitat availability for aquatic organisms.

Photo 74. Left bank erosion in EC02. Habitat structures in this section could stabilize the streambank and improve instream habitat.

Photo 75. Large boulder habitat in EC02 upstream of the Water Tank Run confluence.

Photo 76. Looking upstream beginning of EC01 at the confluence of Water Tank Run and EC02.

Photo 77. Right bank erosion in EC01. The instream habitat in this section could be improved with large woody debris addition or habitat structures to create flow, substrate, and depth variabilities.

Photo 78. Cement armored bank in EC01. Though the cement stabilizes the soil on the streambank, the lack of vegetative cover on the streambank poses a threat to habitat and water quality in Elk Creek. Riparian vegetation slows stormwater runoff as it flows down the streambank, traps sediment, and uptakes nutrients in the runoff.

Photo 79. Gravel bar, left bank erosion, and woody debris in EC01.

Photo 80. Root wad and woody debris in the stream channel in EC01.

Photo 81. Severe left bank erosion in EC01 on the powerline right-of-way.

Photo 82. Long, eroded left bank along the powerline-right-of way.

Photo 83. Looking upstream from the beginning of segment EC14, downstream of the Elk Creek and Seventy One Run confluence.

Photo 82. The confluence of Elk Creek and Seventy One Run (yellow circle) at the beginning of EC14.

Photo 83. Looking downstream from the beginning of EC14.

Photo 84. Right bank erosion in EC14.

Photo 85. Left bank erosion near Highway 120 in EC14.

Photo 86. Consecutive woody debris jams that provide excellent habitat in EC14.

Photo 87. Left bank erosion at the powerline right-of-way crossing in EC14.

Photo 88. End of segment EC14 looking downstream towards a riparian wetland and the beginning of EC15.

Photo 89. Excellent habitat in the form of woody debris and overhanging vegetation in EC15.

Photo 90. Right bank erosion from a tree falling into EC15. The root wad in the channel provides cover for aquatic organisms.

Photo 91. Excellent habitat in the form of woody debris in EC15.

Photo 92. Eroded left bank and uprooted tree in EC15.

Photo 93. Long section of eroded left bank in EC15.

Photo 94. End of EC15 looking upstream.

Photo 95. Looking upstream at the confluence of EC15 and Daguscahonda Run which begins segment EC08.

Photo 96. Right bank erosion along the railroad bed in EC08.

Photo 97. Unstable streambank in EC08. The landowner mows the vegetation along the streambank.

Photo 98. Riprap bank reinforcement along Highway 120 in the town of Daguscahonda.

Photo 99. Looking downstream at the confluence of EC08 and an unnamed tributary from the south.

Photo 100. Looking downstream from the beginning of segment EC09. The Bridge Street bridge in Daguscahonda is visible in the background.

Photo 101. Looking upstream from the beginning of segment EC09.

Photo 102. Concrete reinforced left bank in EC09 with Highway 120 guardrail visible at the top of the photo.

Photo 103. Silted section of EC09.

Photo 104. Long, embedded pool located in EC09.

Photo 105. Powerline right-of-way encroachment in EC09.

Photo 106. ATV trail crossing in EC09 which cause localized siltation.

Photo 107. Confluence of EC09 with Rocky Run (yellow circle) where EC16 begins.

Photo 108. Large pool with large woody debris in EC16.

Photo 109. Long, eroded left bank in EC16.

Photo 110. Powerline right-of-way encroachment in EC16.

Photo 111. Exposed boulder riffle habitat in EC16.

Photo 112. Root wad in pool habitat in EC16.

Photo 113. Railroad encroachment in EC16.

Photo 114. Left bank erosion on the powerline right-of-way in EC16.

Photo 115. Straightened section of EC16. This section was about 150ft long and 2 feet deep and had very little habitat for aquatic organisms.

Photo 116. Beginning of EC17 looking upstream at the confluence of an unnamed tributary from the north and segment EC16.

Photo 117. Right bank erosion in EC17.

Photo 118. High, eroded left bank in EC17.

Photo 119. Woody debris at the toe of the eroded bank in photo 118.

Photo 120. Utility line crossing EC17.

Photo 121. Looking downstream at the Highway 120 bridge over EC17. A gravel bar has formed behind the center abutment.

Photo 122. Eroded bank downstream of the Highway 120 bridge over EC17.

Photo 123. Beginning of segment EC18 looking upstream at the confluence of EC17 and Mohan Run (yellow circle).

Photo 124. Right bank erosion in EC18.

Photo 125. Debris jam and gravel bar in EC18.

Photo 126. Exposed boulder habitat in EC18.

Photo 127. Railroad encroachment on EC18.

Photo 128. Undercut bank in EC18.

Photo 129. Railroad bridge over segment EC18.

Photo 130. Highway 120 encroachment on EC18.

Photo 131. Long, slow-flowing section with very little instream habitat.

Photo 132. Mowed yard encroaching into the riparian area upstream from Ridgway Powdered Metals.

Photo 133. Right bank erosion upstream from the railroad bed.

Photo 134. Right bank erosion in EC18 with Ridgway Powered Metals in the background.

Photo 135. EC18 flowing along the railroad by Ridgway Powered Metals. The railroad elevation creates a levy and does not allow water passage.

Photo 136. Cement reinforced bank along Highway 120 in EC18.

Photo 137. Looking downstream from the beginning of segment EC19.

Photo 138. Concrete reinforced streambank in EC19.

Photo 139. Highway 219 truck lane bridge over EC19.

Photo 140. Boulder and cobble dominated section of EC19.

Photo 141. Bedrock bottom section of EC19.

Photo 142. Gabion basket bank stabilization upstream from the PennDOT building.

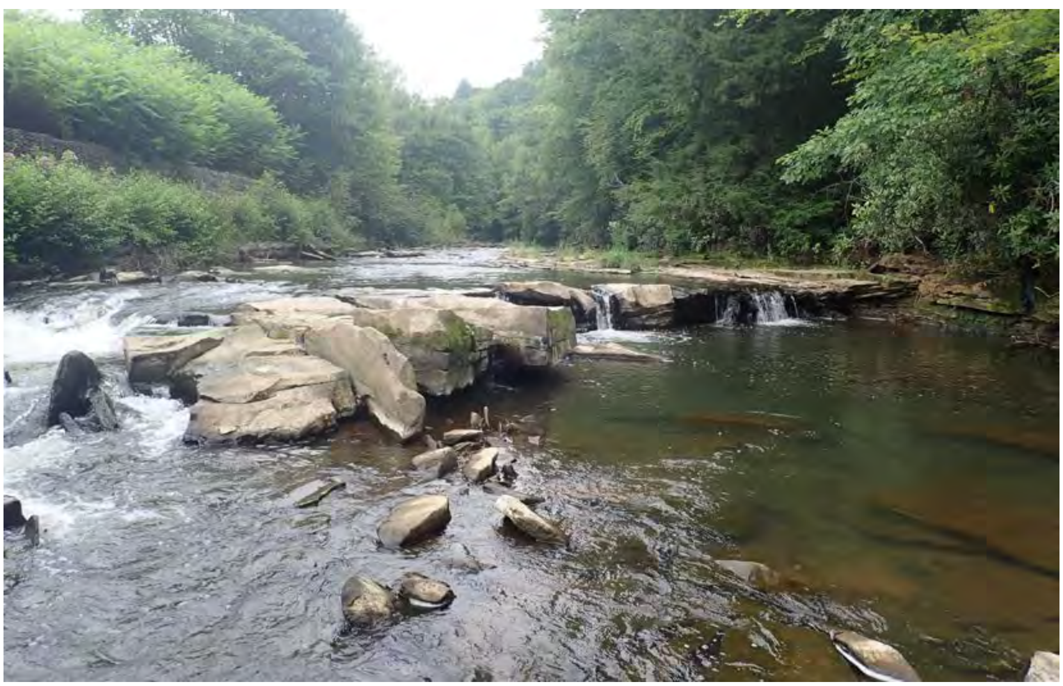


Photo 143. Small waterfall upstream from the PennDOT building.

Photo 144. Right bank erosion and riprap bank stabilization near the PennDOT building.

Photo 145. Creek access ramp behind the PennDOT building.

Photo 146. Riprap bank stabilization and house in the floodplain in Ridgway in EC19.

Photo 147. Riprap bank stabilization upstream from the Broad Street bridge.

Photo 148. Houses in the floodplain along EC19.

Photo 149. Channelized portion of EC19 looking upstream at the Depot Street bridge.

Photo 150. Concrete retaining wall and bank stabilization upstream of the Highway 219 bridge in EC19 in Ridgway.

Photo 151. Looking downstream at the confluence of Elk Creek and the Clarion River just beyond the Tanner Street bridge.

## Section3. Tributary Summaries

### Beaver Run

### Description

The headwaters of Beaver Run originate from a spring in the backyard of private property at 914 Fairview Road in Fox Township. From its origination, Beaver Run flows west, crossing under Fairview Road before it routes North West behind the Fox Township Park. From the Fox Township Park until it enters Seneca Resources property, Beaver Run is a low-gradient stream which weaves through active and relic beaver ponds. The riparian area is largely beaver meadow habitat up until Seneca property, where the land cover becomes a mature hemlock forest. Beaver Run is 6.2 miles long and is a second order stream when it enters Daguscahonda Run on Seneca Resources property. The watershed drains 4.42 $mi^2$ of land which is predominately forested (51.3%) (Homer et al., 2012). Pasture and hay fields are the dominant land use, comprising 14.2% of the watershed area. Low, moderate, and high intensity urban development comprise a combined 5.9% of land use.

Beaver Run is low-gradient throughout the headwaters and becomes confined between the steep, v-shaped valley beginning on Seneca Resources property. The stream is mostly step-pool/cascading habitat and elevation decreases quickly within the valley before it confluences with Daguscahonda Run. Due to rapid change in elevation, boulders and pools were abundant and presented good habitat for fish; however, large woody debris within the channel was noticeably absent. Tannic water and flocculence were observed in segment BV02 due to dissolved organic carbon sourced from wetland habitat upstream. Specific conductivity ranged from 22.1 to 157.4 µS/cm and pH varied from 4.4 to 7.6 throughout assessed sections.

### Threats & Recommendations

Minor stream impacts from the powerline right-of-way (Photo 10) and ATV fords (Photo 3, 4, 10) were observed throughout Beaver Run. Stream sections flowing through the powerline right-of-way lacked overhanging vegetation and were fully exposed to sunlight. The exposed sections were a stark contrast from the forested landscapes which they enter and exit before reaching the powerline and could present thermal barriers for Coldwater fish species (Petty et al., 2012). We observed fords in sections BV01 and BV02 which were causing localized sedimentation issues. Though impacts from ATV fords were localized and minimal, improvements can be made to reduce further erosion and sedimentation. ATV trails could be stabilized by placing stone on the trails. Conveyor belt diversions could be placed along the trail leading into the stream prevent stone from washing away during storms and to hold stone in place while ATV use the trail.

Beaver Run is on DEP's integrated list as impaired by unknown causes. BV02 had orange-colored water (Photo 1) and a pH of 4.4 at the top of the reach and pH increased to 4.5 before it confluenced with BV03. Low pH and orange coloration can be indicators of acid mine drainage. Additionally, aerial satellite imagery revealed orange-colored wetlands upstream of BV02. However, data available for the area does not indicate mining occurred within this specific location in the watershed, but occurred higher up in the headwaters. Ground investigation of the watershed near Raven Run Road in Kersey revealed undocumented coal refuse piles which may cause acidic stream water. Further investigation into the extent of mining activities in the watershed is recommended to appropriately diagnose the cause of water quality impairment.

Specific conductivity was 157.4 µS/cm at the bottom of BV01 and 117.6 µS/cm at the bottom of BV03. These levels are well above normal for the Allegheny Plateau Ecoregion (12 - 72 µS/cm) (Griffith, 2014). Water with elevated specific conductivity was likely sourced from BV01, or its associated branches, and then diluted with from BV02, as BV02 had normal levels of specific conductivity (22.1 and 22.5 µS/cm). One cause of elevated specific conductivity could be due to acid mine drainage or runoff from coal refuse piles within the watershed. Further ground trothing is required to confirm that speculation. Another cause for elevated specific conductivity could be surrounding land use and land cover (Paul & Meyer, 2001). Nutrient pollution from agricultural runoff could be a potential cause of elevated specific conductivity in Beaver Run, as approximately 147 acres within the Beaver Run headwaters are currently used as pasture and hayfields and an additional 133 acres are planted with row crops. WikiWatershed analysis predicts row crop agriculture contributes the greatest concentrations of nitrogen to Beaver Run- about 509 lbs per year. Hay and pasture fields contribute an additional 443 lbs of nitrogen annually. Specific conductivity levels could be improved by agricultural best management practices. Practicing cover crops on just one acre of land could reduce nitrogen-loading by 1.3 lbs annually to Beaver Run. In theory, using cover crops on all land which is traditionally tilled within the watershed would reduce nitrogen loading by an estimated 28%. Additional best management practices, like installing forested buffer around row crop fields can also reduce nutrient loads. One acre of forested buffer reduces nitrogen loading by 8.0 lbs annually.

Photo 1. Dark, tannic water in BV02.

Photo 2. Flocculation in BV02.

Photo 3. ATV crossing in BV02 looking at the left bank.

Photo 4. ATV crossing in BV02 looking at the right bank. The trail lacks substrate and fines wash into the stream channel.


Photo 5. Boulder cascade in BV01. Beaver Run was confined within V-shaped valleys and step-pool and cascade habitats were dominant.


Photo 6. V-shaped valley of BV02. Section BV02 was also confined within a steep valley. Boulders, cascades, and step-pool habitats were common.

Photo 7. Large woody debris recruitment in BV01.

Photo 8. Upstream of a debris jam in BV01.

Photo 9. ATV crossing in BV02. Continuous crossing has created a pool in the center of the crossing. The pool is becoming aggraded with fines and silt washing off of the trail (yellow circle).

Photo 10. Beaver Run flowing through the powerline right-of-way. Water is slow-flowing and warm and could present a thermal barrier for coldwater species.

## Daguscahonda Run

### Description

Daguscahonda Run drains 13.3 $mi^2$ of land and confluences with Elk Creek in the village of Daguscahonda between Ridgway and St. Marys. Daguscahonda Run begins near Main Street in Kersey and it becomes a 3rd order stream after its confluence with Beaver Run. Daguscahonda Run confluences with Decker Run further downstream, but it remains a 3rd order stream upon entering Elk Creek. The Daguscahonda Run watershed is mostly forested (63%) with Hemlock and Beech species dominant within the riparian areas (Homer et al., 2012). Hay and pasture fields are the largest land use (14%) within the watershed. Developed land use occupies nearly 6% of the watershed area and is concentrated in the headwaters surrounding Kersey.

### Instream Habitat

DG01 begins from a culvert under Shawmut Lane (Photo 1). At the culvert, Daguscahonda Run is a first order stream about 3 feet in width. Water was clear with a pH of 7.0 and normal conductivity (66.5 µs/cm). Blacknose Dace were observed upstream from the culvert. Substrate size was large in DG01, with boulders comprising about 45% of the substrate in the stream channel (Photo 2). Though there was boulder and pool habitat available, large woody debris was absent from the channel. Water color was normal until DG01 met the main stem of Daguscahonda Run at the beginning of segment DG06, where color was slightly orange and water quality began to decline. At this point, Daguscahonda Run is listed due to high metal concentrations from acid mine drainage (Photo 5). Water color becomes increasingly more orange and specific conductivity increases to 354 µS/cm by the time Daguscahonda Run confluences with Beaver Run, which is another listed stream. We observed four different acidic seeps along DG06, which we presumed to be the cause of water quality degradation and discoloration (Photo 9, 10, 11, 12). Daguscahonda Run remains orange in color, dominated by larger substrate, and lacks large woody debris until its confluence with Decker Run. A tributary from the western portion of the basin helps dilute Daguscahonda Run before its confluence with Decker Run. Specific conductivity improves to 136.8 µS/cm before the confluence with Decker Run. We did not observe any fish in sections DG06 or DG07 and Daguscahonda Run remains listed until its confluence with Elk Creek.

### Threats and Recommendations

The largest threats to Daguscahonda Run were the four AMD seeps in section DG06. The seeps had pH levels of 2.7, 3.0, and 4.4 and elevated specific conductivity readings of 344 µS/cm, 1395 µS/cm, and 1855 µS/cm. During assessment, it was evident the seeps had been impacting the stream long-term, as rocks and substrate were stained orange, coated in biofilm, and we did not observe any fish, macroinvertebrates, or aquatic plants. DEP mining data do not indicate mining activities occurred in the assessed portions of the watershed. The closest documented mining area is located on the Pontzer property, in the eastern headwaters, approximately 2.25 miles upstream (Pennsylvania Department of Environmental Protection, 2019). Landowners confirmed the stream has been impacted since at least the 1970s and that some form of mining activity occurred about 1.25 miles upstream from DG01, though this area is not documented by DEP either. Google Earth imagery reveals orange-colored wetlands upstream from the three seeps which were identified during assessment. The documented mining area is an abandoned mine shaft opening, so it is possible that underground mining took place downstream in the watershed and the only documented impact point is the mine shaft; however, there are documented refuse piles about a quarter mile west of the mine shaft. The refuse piles are in very close proximity to the stream and one of the piles is not reclaimed. The refuse piles may provide some explanation as to why water quality declines as DG01 confluences with DG06. The seeps observed along DG06 are not close to the refuse piles, but it is possible that groundwater is contaminated from mining activities that occurred higher in the watershed and the contaminated groundwater upwells from wetlands located near DG06 and from the streambanks near DG06.

A more thorough investigation of AMD seeps in the upper watershed is recommended. After identifying the extent of the seeps, discharges and pollutant loadings from each seep should be quantified in order to determine the best course of remediation. Depending on water chemistries and discharges, Daguscahonda Run could potentially be treated with lime addition or passive treatment ponds. It is also recommended that the refuse pile be reclaimed, either by hauling away the leftover materials or by lime addition and revegetation. The most appropriate course of action for reclamation depends on the quality of the refuse.

Other threats to Daguscahonda Run include development in the headwaters, ATV trail crossings, and riparian zone mismanagement. Portions of Daguscahonda Run in the more developed, upper headwaters were not assessed due to access restrictions, but we visually observed typical threats to streams which flow through urban centers, such as channelization, streambank reinforcement, and stream burial driving through Kersey. These common urban stream habitat stressors have created homogenized instream habitat in the headwaters of Daguscahonda Run. Homogenized habitats support less diverse aquatic communities and have less capacity for ecosystem processes, such as productivity or nutrient cycling (Beisel, Usseglio-Polatera, & Moreteau, 2000; Groffman, Dorsey, & Mayer, 2005). The ATV trail crossings present minimal threat to habitat quality in Daguscahonda Run. Substrate size in Daguscahonda Run is large enough that the crossings were not embedded nor badly eroded. Lastly, camp yards located in the lower watershed are maintained so that there is no native riparian vegetation. In some areas, mowing and maintaining the riparian zone has caused bank instability which has been treated with riprap (Photo 13). Riprap does not provide quality habitat for aquatic organisms. For development which encroaches onto Daguscahonda Run, Fish and Boat habitat structures and riparian buffer installation are recommended. For landowners who do not wish to install riparian buffers, habitat structures could be a good comprise to ensure banks are protected and habitat is improved. However, the habitat/bank stabilization projects are lower priority than remediating water quality due to AMD issues.

Photo 1. Beginning of DG01 at culvert on Timm property. Blacknose dace were observed at this stream crossing.

Photo 2. Segment of DG01 dominated by large substrate. DG01 was comprised of mostly boulders (45%) and riffle/pool habitats were the most common.


Photo 3. Another example of the large substrate in DG01. This particular section of DG01 was slightly silted and embedded.

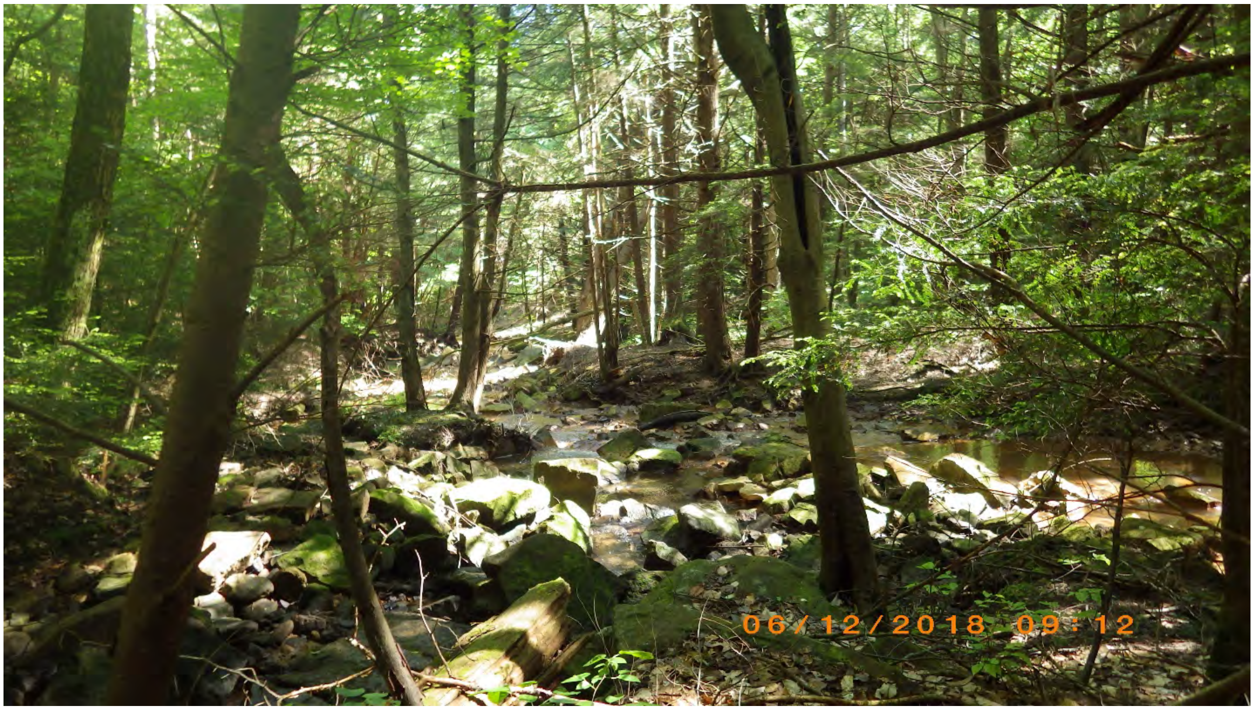


Photo 4. Looking downstream at the confluence of DG01 and the main stem of Daguscahonda Run. The main stem of Daguscahonda Run is a 3rd order stream at this confluence and has poor water quality. The main stem is the orange stream on the right side of the picture.

Photo 5. A close-up of the confluence of DG01 and the main stem of Daguscahonda Run looking downstream. The main stem is orange and water quality begins to decline at the confluence.

Photo 6. A close up of the discolored water in the main stem of Daguscahonda Run at the confluence with DG01.

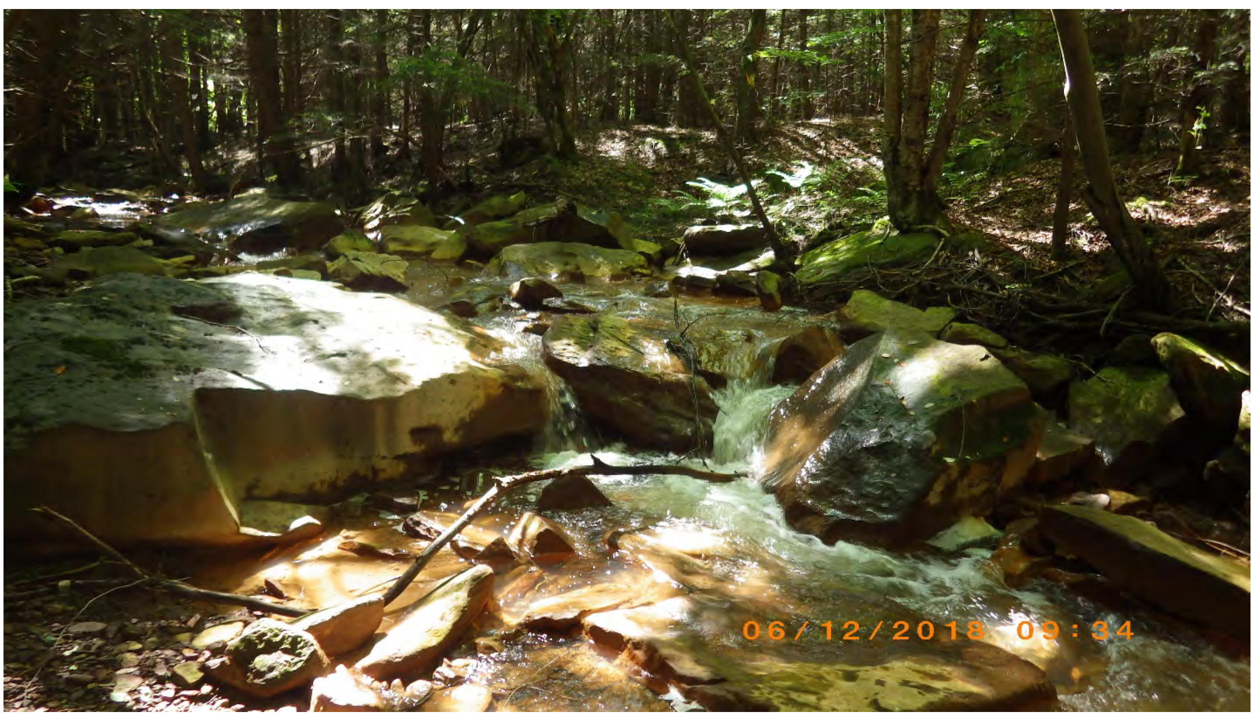


Photo 7. Looking upstream in segment DG06 which is the main stem of Daguscahonda Run. Substrate size remains large through this segment and the water quality continues to decline. Water and substrate are orange throughout this segment.


Photo 9. Looking at the confluence of the first AMD seep with DG06 (41.37907, -78.63179). Specific conductivity was 1395 µS/cm and pH was 3.0 in this seep.


Photo 10. Looking uphill at the first seep from segment DG06. The seep has created a small channel or has polluted a headwater stream.


Photo 11. The third AMD seep observed in DG06 (41.37833, -78.63177). Discharge from this seep was low during assessment. pH was 2.7 and specific conductivity was 1395 µS/cm in this seep.


Photo 12. The fourth seep in segment DG06 (41.38760, -78.63167). Specific conductivity was 663 µS/cm and pH was 4.0.

Photo 13. Looking downstream at a camp along segment DG07. Riprap lines the streambank to prevent erosion.

Photo 14. Looking upstream at the confluence of Decker Run and DG07.

## Decker Run

### Description

Decker Run is a first order stream that flows for 2.3 miles in the village of Daguscahonda. The watershed drains 1.35mi$^2$ before it confluences with Daguscahonda Run on the Kornacki property, about 1.5 miles west of the Laurel Run Reservoir. With the exception of a 0.10 mile section on the Kornacki property, the Decker Run watershed is covered entirely by forest and is owned by Seneca Resources. Decker Run has a 6ft average stream width as it flows over mostly boulder and cobble substrate on its way to Daguscahonda Run. Flow was low during assessment and the most dominant velocity/depth regimes were slow and fast shallow. At times, the majority of the flow was subsurface beneath boulders. Large woody debris and undercut banks were abundant and provided cover for aquatic organisms. The pH at the top of Decker Run was 6.1 and decreased to 5.0 at the confluence with Daguscahonda Run. Conductivity was low throughout the stream and never exceeded 24.7 µS/cm.

### Threats and Recommendations

The largest threats to Decker Run were two undersized culverts and an ATV trail crossing (Photo 6). The downstream culvert consisted of 4 metal pipes beneath an ATV trail and presented an aquatic organism passage issue. The pipes had an outlet drop of approximately 1 foot and the majority of the stream water flowed through one center pipe. A series of 3 inch metal pipes were embedded vertically into the streambed upstream of the culvert (Photo 2). The pipes captured debris and caused sediment to aggrade to result in a large, dry sediment bar upstream that forced the stream to reroute to the edges of the channel. The ATV crossing, located on Seneca Property just downstream of where the Decker Run begins, presented a minimal threat to stream health (Photo 6). Very little sedimentation and erosion were observed at the time of assessment. The culvert at the beginning of Deck Run, beneath a Seneca Road, consisted of 2 metal pipes approximately 18 inches in diameter (Photo 4). Debris and sediment clogged the inlet to the culvert. A pool formed upstream from the sedimentation which created an inlet drop from the streambed to the pipe. The pipe closest to the right bank was nearly clogged during assessment and had very little stream flow. We hypothesize both culverts to be barriers to fish passage. Wild trout were only observed downstream of the lower culvert.

Replacing the lower culvert pipe is recommended to promote aquatic organism passage (Photo 3). The culvert should be replaced with a single, adequately sized structure at the appropriate grade. The culvert replacement would reconnect a mile of stream for fish habitat. Replacing the upper culvert is not a priority, as Decker Run is intermittent upstream. Installing conveyor belt stormwater diversions on the ATV trail crossing is another low priority project, but could prevent erosion and sedimentation during rain events.


Photo 1. Outlet of culvert immediately upstream from the Daguscahonda/Decker Run confluence.

Photo 2. Inlet of the culvert from photo 1. Vertical metal pipes blocked debris from entering the culvert pipes, but created a large sediment bar upstream.

Photo 3. Beginning of Decker Run and clogged culvert pipes. A pool formed behind the pipes (yellow circle) due to debris and sediment aggradation.

Photo 4. Outlet of the pipes from photo 3. The majority of stream flow routes through the pipe closest to the left bank due to debris jams at the inlet.

Photo 5. Step-pool habitat with low, slow-flowing water. The majority of the substrate in Decker Run looked similar to the above photo.


Photo 6. ATV trail crossing which presents little threat to the stream.

## Gallagher Run

### Description

Gallagher Run begins on State Game Lands 44 near the top of Bootjack Hill in Ridgway The stream starts from a hillside spring that is edged in large foundation stones about one-tenth of a mile west of where Mountain Laurel Lane connects to Highway 948 (Photo 1). Gallagher Run is a first-order stream that flows for 3.5 miles through a steep, confined valley before entering the town of Ridgway and meeting Elk Creek behind the Public Welfare Department Building on Race Street. The first 2.0 miles of Gallagher Run flow through forested State Game Lands until it enters a man-made dam on the Heindl property. The remaining length of Gallagher Run flows through downtown Ridgway. Of the 2.14 $mi^2$ drainage area, nearly 75% of the area is forested (Homer et al., 2012). Development is the largest land use in the Gallagher Run watershed and accounts for about 16% of the watershed area. Half of the development is classified as low and moderate intensity. All of the development occurs in the lower third of the watershed.

As Gallagher Run begins, the channel substrate was predominantly sand and silt but quickly shifted to boulder and cobble-dominated substrate as it proceeded down the confined, v-shaped valley (Photo 4). The riparian area was largely intact as it flowed through the Game Lands and the stream was 100% shaded predominantly by species of beech, maple, oak, and mountain laurels. Overall, substrate embeddedness was rated as suboptimal. Riffle substrate was not extremely embedded, but all depositional or slower-flowing areas were covered in deep sand and silt. Gallagher Run had many large boulders and sometimes flowed subsurface beneath large boulder outcroppings. Difference in stream bed elevation above and below some boulder sections were as high as 6 feet; however, native Brook Trout were observed throughout Gallagher Run and appeared to have no issues navigating above and below the boulders. Six wild Brook Trout, each about 6 inches in length, were observed throughout the assessed portion of Gallagher Run. Specific conductivity and pH were elevated. Specific conductivity was 97.6 at the beginning of the segment and increased to 112.7 at the bottom of the segment. pH decreased from 7.7 to 7.1 by the bottom of the segment.

### Threats and Recommendations

Erosion was the largest threat to habitat integrity in the assessed segment of Gallagher Run (Photo 8, 9, 13). The majority of the erosion occurred near old bridge abutments and roads. The abutments and roads are presumably leftover from former logging activities. There is also a lack of large woody debris throughout the assessed segment of Gallagher Run, which may be due to former logging activities, as well. Many areas in the upstream portion of Gallagher Run, on the PA Game Lands property, could benefit from large wood addition. Controlling grade with logs, as well as slowing water to create more pool habitat, could help prevent erosion upstream. Chop and drop wood addition is the most feasible restoration technique in the upper section of Gallagher Run due to its remote location.

Urban development was a large threat as Gallagher Run flows through Ridgway. Due to the majority of the stream channel being under private ownership, Gallagher Run through

Ridgway was unable to be formally assessed; however, a lot of the stream is visible from public roads. Gallagher Run was disconnected from its floodplain throughout the town of Ridgway. Many of the streambanks had been replaced with brick or block walls which confined the stream channel to cause erosion and instream habitat degradation (Photo 16-19). Portions of Gallagher Run were piped and flow underground through Ridgway. Flowing through underground pipe causes ecosystem disconnection and slows the processing of nutrients and organic materials (Kaushal & Belt, 2012; Walsh et al., 2005). Additionally, pipes do not allow for groundwater exchange and prevent groundwater recharge (Kaushal & Belt, 2012). Changes to nutrient and organic matter processing may result in greater concentrations of nutrient loads entering Elk Creek from Gallagher Run.

Though it may regulate flood water of Gallagher Run before entering Ridgway, the dam on Gallagher Run presents a barrier to aquatic organisms and material transport. Upstream of the dam we observed native Brook Trout that are undoubtedly a cutoff population. Isolated populations, unable to breed with organisms outside of their range, have reduced genetic variation and may make individuals more susceptible to disease, ecosystem alteration, and genetic inbreeding. Trout can travel long distances in search of thermal refuge or spawning sites (Petty et al., 2012). Barriers, like the Gallagher Run dam, can prevent trout movement to cooler waters upstream in warmer weather. Upstream movement to Gallagher Run is critical for trout health throughout lower Elk Creek, as flood management projects in the lower section of Elk Creek have stripped the stream channel of habitat and refuge. The dam not only prevents aquatic organism movement, but it starves downstream Gallagher Run of material necessary to maintain a healthy stream ecosystem. Headwater streams transport sediment and detritus sourced from forested ecosystems to larger streams (Vannote, Minshall, Cummins, Sedell, & Cushing, 1980). Sediment and detritus are currently stored in the dam.

Because the dam on the Heindl property prevents downstream transport of aquatic organisms in a wild trout stream, constructing a fish passage structure is highly recommended. A passage structure would help to reconnect the upstream fish population to the fish populations in Elk Creek. Fish passage could be accomplished using a variety of methods, such as a full width rock-ramp, partial width rock ramp, or bypass fishway. The most appropriate design for a fish passage structure would depend on the available area for construction and the overall slope of the stream. Additionally, the structure would need to be installed on private property and would require landowner agreement and support.

Gallagher Run downstream of the dam flows through downtown Ridgway, where it experiences stormwater stressors and degraded instream habitat. The majority of the streambanks are reinforced with concrete or brick walls and gabion baskets (Photo 20, 22). Though the hard engineering of the streambanks help to prevent erosion, they create floodplain disconnection, increase sheer stress along banks, and provide no habitat for aquatic organisms. Additionally, Gallagher Run has very little riparian area vegetation as it flows through Ridgway. In locations where riparian vegetation can grow, the vegetation is typically lawn grass and kept maintained with mowing to the edge of the streambank. Lawn grass provides no overhanging cover for aquatic organisms in the stream channel and very little streambank stabilization due to its shallow root systems. Lack of diverse, native vegetation on the streambanks further contributes to a lack of food resources for aquatic organisms in downstream Gallagher Run.

PA Fish and Boat habitat structures, natural streambank stabilization structures, and removing stream impoundments are recommended for the lower portion of Gallagher Run. Instream habitat in Gallagher Run throughout Ridgway is severely impacted due to encroaching urbanization and manmade structures built to prevent erosion. Walls surrounding the stream in some areas of town cannot be removed because they are likely the only protection between the stream and houses in those areas; however, efforts should be made to increase habitat variably in walled sections of Gallagher Run. Because the walls do not allow Gallagher Run to access the natural floodplain, stormwater flows through at high velocity and takes with it sediment and debris. To retain habitat and food for aquatic organisms, random boulder clusters could be placed throughout the stream. The boulder clusters will naturally form pools and sediment bars to reduce habitat homogeneity. As Gallagher Run flows past the YMCA basketball courts, the gabion baskets should be removed and the streambank should be regraded to a 3:1 slope. Log or rock cross vanes should be installed at the toe of the slope built to PA Fish and Boat Commission specifications. Grading the streambank will likely involve a slight relocation of a paved walking trail. Gentler slopes will help reduce water velocity and consequently prevent erosion. Cross vanes will also prevent erosion by directing flow into the center of the stream channel and away from streambanks. A vegetated riparian buffer should also be maintained in this area as it will further serve to stabilize streambanks.

Photo 1. Beginning of Gallagher Run from spring landscaped with boulders.

Photo 2. Inlet of PA Game Commission dirt road culvert. The inlet drops about 6 inches from the stream bottom, which has aggraded, to the bottom of the pipe.

Photo 3. Outlet of the same culvert from photo 2. The outlet drops about 8 inches from the bottom of the pipe to the bottom of the stream. A lack of substrate in the pipe, as well as fast and shallow flow, could create aquatic organism passage issues at low flow.

Photo 4. V-shaped valley of Gallagher Run Watershed. Gallagher Run flows along the bottom of steep hill to its East. Substrate was small and a lot of silt was observed in the headwaters. A native Brook Trout was observed in this location.

Photo 5. Looking downstream at old bridge abutments made from large, cut boulders.

Photo 6. Upstream view of the relic abutments in photo 5. There was an approximately 2ft tall step before the former location of the bridge.

Photo 7. A former logging grade or trail in the riparian of Gallagher Run now overgrown with Hemlock.

Photo 8.  Left bank erosion.

Photo 9. Left bank erosion at the base of former logging road/trial.

Photo 10. Plunge pool created by woody debris and tree roots.

Photo 11. Long pool which lacks habitat. This location would be a great candidate for large woody debris addition by dropping surrounding hemlocks into the stream channel.

Photo 12. Plunge pool created by boulders, tree roots, and woody debris.

Photo 13. Left bank erosion at the toe of an ATV trail.

Photo 14. Former bridge abutments made from cut boulders along the stream channel. Some erosion is present on the left bank where the abutments are falling into the stream channel.

Photo 15. The end of the assessed portion of Gallagher Run before it leave Game Commission land and enters private property.

Photo 16. Looking downstream from bridge under Bootjack Road. Gallagher Run is impounded by walls and flows hazardously close to residential structures.

Photo 17. Looking upstream at Gallagher Run from the bridge under Depot Street. Gallagher Run has very little habitat for aquatic organisms.

Photo 18. Looking upstream from a footbridge at St. Leo's Catholic School. The stream is impounded with gabion baskets which are falling into the stream channel.

Photo 19. Looking downstream as Gallagher Run flows through St. Leo's Catholic School property. Drains that outlet immediately into the stream channel (left) do not allow for settling and assimilation of stormwater contaminates before reaching the stream.

Photo 20. Looking upstream from the bridge under South Broad Street near the Ridgway YMCA.

Photo 21. Looking upstream at Aiello's Café from the Ridgway YMCA basketball courts. The stream through this segment of the property is entirely lined by gabion baskets and lacks instream habitat.

Photo 22. Looking downstream from the YMCA basketball courts towards the confluence with Elk Creek. The stream is lined with gabion baskets, lacks instream habitat, and has very little vegetated riparian zone.

## Iron Run

### Description

Iron Run has two headwater segments which conjoin on the Pistner property behind a self-storage facility off of Pistner Road. Both headwater segments are 2nd order streams at the Pistner Road confluence, making Iron Run a 3rd order stream when it enters Elk Creek. Iron Run flows for 9.6 miles and drains 5.2 $mi^2$ of land in the southern portion of Saint Marys City. The northern headwater branch begins from a pond on the Herbstritt property near the intersection of Airport Road and Camp Owners Road. The southern headwaters begin in a wetland on the Nesbitt property at the end of Ford Road Extension. Forest is the most dominate land cover and accounts for about 38% of the watershed area (Homer et al., 2012). Development accounts for 32.6% of the watershed area. Of the developed watershed area, the majority (84.4%) is open space and low intensity development. Agriculture, mostly in the form of hay and pasture fields, occupies 20% of the watershed area. The majority of Iron Run is privately owned, thus, only segments of the stream through Benzinger Park and Saint Marys High School properties were assessed.

An unnamed tributary confluences with Iron Run in Benzinger Park (IR01). The unnamed tributary and Iron Run had many Blacknose Dace during assessment. Trout were observed in the main stem of Iron Run in Benzinger Park. IR01 is a stocked trout stream, however, so the trout may not be native. A sidewalk runs parallel to the left bank of IR01 and encroached on the riparian area (Photo 3). The riparian width on the left bank of IR01 was on average 5 meters wide. When Iron Run entered and left Benzinger Park, the riparian area was wider and consisted of Hemlock trees. Though once the stream crossed under Vine Road, development continued to encroach on the riparian area as it wove through residential areas before entering Elk Creek. The unnamed tributary which confluences with Iron Run in Benzinger Park was nearly void of riparian vegetation and passed through many culverts (Photo 8). The culverts were in poor physical condition and may create barriers to fish passage at low flow (Photo 4, 13, 14). Specific conductivity and pH were elevated in IR01 and the water had a red sheen/coloration.

Iron Run through the Saint Marys Area High School (SMAHS) property, IR02, had an intact riparian buffer composed of mostly Hemlock trees. Fish habitat was higher quality throughout IR02 compared to IR01. Due to the easily eroded soils, streambanks and trees along the stream channel were undercut and provided habitat for fish (Photo 11). Though the eroded soils were deposited within the stream channel and caused substrate to be embedded. Additionally, IR02 had large woody debris in the stream channel which provided habitat for fish (Photo 12). Trout were observed through the stream on SMAHS property, but it was unclear whether the trout were native or stocked. Specific conductivity and pH were elevated. IR02 ended just before the SMAHS driveway to Highway 120 where the left bank is a privately-owned cow pasture.

### Threats and Recommendations

Iron Run is on DEP's Integrated List as impaired. The southern headwaters and the main stem of Iron Run are impaired due to metals from acid mine drainage. The northern headwaters are listed from unknown causes. Specific conductivity measurements collected from Iron Run during assessment ranged from 66.5 to 233 µS/cm. The normal specific conductivity range for Northern Appalachian Plateau streams is 12 – 72 µS/cm (Griffith, 2014), so the elevated specific conductivity readings collected during assessment were likely caused by the already documented acid mine drainage. The DEP Office of Surface Mining reports an abandoned mine discharge area and a dry strip mine within the subwatershed of the northern branch of the Iron Run headwaters, although the Integrated List reports the water quality in the northern headwaters to be impaired by unknown causes (Pennsylvania Department of Environmental Protection, 2019). If groundwater is contaminated from these mining areas, then it is logical that southern headwaters are AMD impaired. However, the cause of impairment in the northern headwaters may easily be explained by AMD surface flow in the subwatershed. The source of acid mine drainage within the Iron Run watershed should be located and the water quality and quantity from these sources should be quantified to determine the best course of treatment. Funding for these investigations, and eventually remediation efforts, is available through the DEP Growing Greener Grant Program and the Abandoned Mine Drainage Abatement and Treatment Program. Both grants require a 15% minimum match, which should be secured prior to applying for funding.

Urbanization is a water quality and stream habitat concern for Iron Run. Development has encroached upon the riparian buffer. The encroachment is a concern because riparian buffers work to settle sediment and absorb nutrients from stormwater surface flows before reaching stream channels (Naiman & Decamps, 1997). Riparian buffers are particularly important in heavily impervious areas, as these areas produce greater quantities of runoff during storms. Additionally, portions of Iron Run flow through residential areas in culverts. Misaligned and undersized culverts can create aquatic organism passage issues and alter stream channel morphology. Road crossings should be surveyed and monitored for stream habitat impacts and aquatic organism passage issues. If culverts are found to be undersized, poorly aligned, and/or barrier for aquatic organism passage, they should be replaced. Culvert replacement can be costly; however, some low volume roads throughout the watershed would be eligible for the Conservation District's Low Volume Road funding to help lessen the overall cost of the project. Drains are another urban threat that bypass riparian areas and outlet pollutant-rich water directly into the stream channel (Kaushal & Belt, 2012).

Nutrient pollution is another water quality concern for Iron Run. Though nutrient samples were not collected during assessment, elevated specific conductivity values could be associated with excess nitrogen and phosphorous concentrations in stream water. Some areas of Iron Run southern headwaters are outside of public sewer service and were observed to have malfunctioning septic leach fields. Malfunctioning septic leach fields and agriculture could be sources of excess nutrients. The malfunctioning leach fields were identifiable by puddles of raw sewage in the front lawns of homes. The raw sewage overflows into roadside ditches which outlet to Iron Run. Agriculture is another potential source of excess nutrients. Some portions of Iron Run flow through crop and pasture fields. Some fields have vegetated buffers and fencing surrounding streams to prevent fertilizer runoff and cattle access to the stream. However, cattle were observed to have access to some parts of Iron Run during assessment. In addition to nutrient pollution, cattle access to streams can cause increased rates of streambank erosion and instream habitat degradation. WikiWatershed analysis predicts hay and pasture fields to be the largest sources of nutrients to Iron Run, contributing 578 lbs of nitrogen and 234 lbs of phosphorus to the stream annually. Septic systems in the watershed contribute an addition 398 lbs of nitrogen per year, according to WikiWatershed.

Septic systems polluting Iron Run with raw sewage and effluent should be repaired or replaced. Septic system repairs can be costly, but there are programs available to financially assist homeowners. PENNVEST has an On-lot Sewage Disposal and Lateral Repair Loan Program that allow homeowners to borrow $25,000 at an interest rate of 1.75% for up to 20 years for septic system installation, repair, or connection to public service. Lower income homeowners may be eligible for the Keystone Renovate and Repair Loan Program, which funds the same repairs and installation as the PENNVEST Loan. Ideally, the City of Saint Marys would extend public sewer services to more areas within the Iron Run watershed to prevent sewage pollution, but expansions are costly and sometimes met with backlash from homeowners who do not wish to pay tap-in fees and monthly sewer bills.

Mowing and thinning of riparian vegetation is another urban threat. Riparian vegetation shades stream channels and keeps water temperatures cool. Iron Run is a coldwater fishery and water temperatures need to remain cool year-round to support native fauna. Less vegetation and more direct sunlight on the steam channel can increase water temperatures. Vegetated riparian buffers should be maintained and/or widened in areas of development and agriculture. Phosphorus pollution, sedimentation, and thermal impacts associated with urbanization and agriculture can be strongly influenced by the proximity of these land use activities to stream channels. Phosphorus is typically transported adhered to sediment, thus streambank erosion and turbid water entering streams can introduce excess phosphorus (Peterjohn & Correll, 1984). Vegetated riparian buffers can slow water and allow sediment to settle before entering the stream channel; uptake phosphorus and reduce nutrient concentrations entering the stream channel; and directly control stream water temperatures (Sweeney & Newbold, 2014).


Photo 1. Looking upstream at IR01 as it leaves Benzinger Park property.


Photo 2. Undercut bank and exposed tree root fish habitat in IR01.


Photo 3. Looking upstream at gabion baskets along the streambank in Benzinger Park. The stream eroded the right bank near a paved walking trail. The gabion baskets were in poor condition and had protruding wires and were losing rocks to the stream.


Photo 4. Culvert outlet in poor physical condition on the unnamed tributary to IR01 through Benzinger Park. The culvert was a barrier to fish passage during assessment due to low flow.


Photo 5. Channelized stretch of the unnamed tributary to IR01 which could benefit from habitat projects like large wood addition.


Photo 6. French drain from a private residence which outlet to UNT to IR01.


Photo 7. Grass clipping dump pile on the streambank of UNT to IR01.


Photo 8. UNT to IR01 on the perimeter of Benzinger Park.


Photo 9. Beginning of segment IR02 on Saint Marys High School Property looking upstream.


Photo 10. Beginning of segment IR02 looking downstream.


Photo 11. Streambank erosion in IR02. Though undercut, streambanks were relatively stable due to mature hemlock trees growing on the streambanks and riparian areas. The streambank was mostly clay in this section.


Photo 12. Debris jam in IR02 located in pool habitat.


Photo 13. Multiple terra cotta culverts at the end of IR02. The culverts restricted the stream channel width to cause a pool to form around the inlets.


Photo 14. Pasture fencing at the end of IR02. The fence extended out into the stream channel and allowed access to the stream for cows. A cement culvert pipe remained in the channel, but water routed around and underneath the pipe and the pipe was dry upon assessment.

**Laurel Run**

**Description**

Laurel Run feeds the Laurel Run Reservoir, which is the municipal water supply for the City of Saint Marys. The headwaters of Laurel Run begin in Fox Township south of St. Marys. The eastern headwaters begin on Saint Marys Water Authority property and continue through Water Authority property until crossing under the Million Dollar Highway. The western headwaters being on the Ayshire Dairy Farm off of Old Kersey Road and flow through private land. The headwater branches meet to form the main stem of Laurel Run a half mile directly west of Walmart. From this confluence, Laurel Run flows through another half mile of private land before it flows back onto Water Authority property. Laurel Run drains 8.5 $mi^2$ of land within Fox Township and St. Marys. Laurel Run has 15.8 stream miles and is a 3rd order stream when its confluences with Elk Creek downstream of the reservoir. Land cover in the watershed is predominantly forested (70.2%) (Homer et al., 2012). Pasture and hayfields are the largest land use (14%) (NLCD). Developed area only accounts for about 5% of the watershed area.

The eastern branch of the headwaters averaged stream widths of about 4 feet and substrate consisted of mostly sand and cobble. Specific conductivity was low in the eastern headwaters, ranging from 19.9 to 28.1 µS/cm. pH ranged from 4.9 to 6.2. Specific conductivity, pH, stream width, and substrate size increased as Laurel Run crossed under Highway 255 south of St. Marys. Wild Brook Trout were observed before this stream crossing. The western branch of the headwaters, with the exception of LR07, were similar in stream width and substrate size to the eastern branch, but pH readings and specific conductivity were greater. pH ranged from 7.4 to 7.7 and specific conductivity ranged from 88 to 111 µS/cm in the western headwaters. Wild trout were not seen in this section of Laurel Run, but many Blacknose Dace and a few Northern Hog Suckers were observed. Stream segment LR07 had the lowest pH (4.8 – 4.9) and conductivity (30.6 – 31.5 µS/cm) within the western headwaters. LR07 was the only segment in the western headwaters were fish were not observed.

Substrate size, water temperature, pH, and specific conductivity continued to increase along the main stem of Laurel Run until it entered the reservoir. The stream channel was about 30ft wide at the reservoir entrance where stream velocity slowed, gradient decreased, and the channel was backwater ecosystem due to reservoir back flow. Specific conductivity was 130.9 µS/cm, pH was 7.8, and warmwater fish species were present within the backwater. Wild trout were not observed in the main stem of Laurel Run north of Highway 225.

**Threats and Recommendations**

Embeddedness was the largest threat observed during assessment. Though instream substrate size increased as Laurel Run approached the reservoir, embeddedness was rated as suboptimal throughout the majority of Laurel Run. Much of the embeddedness appeared to be natural and not a product of anthropogenic stressors. Soil surveys reveal the Laurel Run watershed is dominated by Wharton silt loam (25%), which is moderately erosive. Wiki Watershed analysis estimates Laurel Run transports approximately 79 tons of sediment annually; however, the majority of the sediment never reaches Elk Creek as it deposits before or in the reservoir. Efforts to avoid excessive sedimentation and embeddedness should be made as these stressors could present issues for reservoir maintenance, water quality, and fish habitat. Efforts should be made to stabilize at-risk streambanks with natural streambank stabilization structures. ATV trail crossings should be stabilized with conveyor belt strips and vegetated riparian buffers should be maintained around the powerline right-of-way to prevent further erosion. Large woody debris addition would be beneficial to Laurel Run as it would help retain sediment while also creating fish habitat.

Segments of Laurel Run contained undersized culverts which could pose barriers to aquatic organism passage (Photo 3-6; 11-12). Additionally, undersized culverts also compromise the integrity of surrounding roads, trails, and streambanks by altering the natural flow regime. Undersized culverts should be replaced with appropriately sized and aligned structures. Replacing the culverts will enhance aquatic organism passage and prevent damage to roads and trails that could result in further erosion and sedimentation.

Photo 1. Looking upstream from the beginning of the assessed portion of LR01. LR01 was intermittent upstream from this photo.

Photo 2. Looking downstream from the beginning of the assessed portion of LR01.

Photo 3. Terra cotta culvert inlet below on LR01. Sediment and debris aggraded at the inlet causing an inlet drop, pooled water, and a potential aquatic organism passage issue.

Photo 4. Outlet of the culvert from Photo 3.

Photo 5. Culvert inlet in LR02. Culvert goes beneath Laurel Run Road on Saint Marys Water Authority Property.

Photo 6. Outlet of the culvert from Photo 5. The outlet is perched about 8inches from the stream bottom and could present an aquatic organism passage issue.

Photo 7. Left bank of an ATV trail crossing. The crossing was embedded as it receives silt from the ATV trail.

Photo 8. The right bank of the ATV trail crossing from Photo 7. Erosion and sedimentation were present.

Photo 9. LR02 leaves the forest and transitions to a low-gradient, slow-flowing stream through a wetland ecosystem.

Photo 10. The remnants of a dam in LR02 that likely created the wetland ecosystem from Photo 9.

Photo 11. Culvert inlet in LR03 that goes beneath a Saint Marys Water Authority property road. Sediment aggraded and caused an 8-inch drop that could present an aquatic organism passage issue.

Photo 12. Outlet of the culvert in Photo 11.

Photo 13. A side channel of LR03 with a cement weir created pool habitat.

Photo 14. Newly deposited sand bars in LR03 and undercut banks.

Photo 15. Culvert inlet in section LR03 created a sand bar and debris jam that could make the culvert unnavigable for aquatic organisms. Culvert goes under a decommissioned section of the Million Dollar Highway.

Photo 16. Culvert outlet from photo 16. The left pipe is slightly perched and flow is low in both pipes.

Photo 17. End of segment LR03 before Laurel Run flows under the Million Dollar Highway.

Photo 18. Culvert outlet under the Old Kersey Road at the beginning of LR04. Aquatic organism passage is likely impeded at low flows. Laurel Run feeds a residential pond just downstream of the culvert.

Photo 19. A segment of LR04 that has clay banks. Clay banks were uncommon in the other assessed streams throughout the Elk Creek Watershed.

Photo 20. Looking downstream at the end of LR04. The stream channel was embedded and was dominated by silty substrate.

Photo 21. Looking downstream at the beginning of section LR06. LR06 was embedded and substrate was dominantly sand and silt.

Photo 22. The confluence of LR07 (left fork) and LR08 (larger stream, right).


Photo 23. ATV ford present on LR07. Silt from the trail washed into the stream channel to create embedded substrate.

Photo 24. Beginning of segment LR08 looking downstream.

Photo 25. Streambank erosion in LR08 where the powerline right-of-way encroaches on the stream channel.

Photo 26. End of segment LR08 with quality fish habitat.


Photo 27. Beginning of LR09 looking downstream. Laurel Run is a 3rd order stream at this location and remains a 3rd order stream until it enters the Laurel Run Reservoir and Elk Creek.

Photo 28. Debris jam in LR09. LR09 had excellent woody debris recruitment.

Photo 29. Habitat variability in LR09. The above photo shows large woody debris, pools, riffles, and undercut banks which would make excellent fish habitat.


Photo 30. Large pool in LR09 which contained large, overhanging boulders.


Photo 31. Right bank erosion in LR09 caused by ATV trail erosion.

Photo 32. Looking upstream at a headwaters stream where it confluences with segment LR10.

Photo 33. ATV crossing in LR10 contributing sediment and fines to the stream channel.


Photo 34. A portion of LR10 which was very embedded and had a newly-deposited sand bar.

Photo 35. Beginning of LR11, the segment of laurel Run before it confluences with the reservoir.


Photo 36. Left bank erosion in LR11.


Photo 37. Bedrock shelf and stream bottom in LR11 just before LR11 enters the reservoir.


Photo 38. LR11 became a slow-moving, shallow, warm stream before it entered the reservoir. Warmwater fish species were observed in this section of the stream.

## Mohan Run

### Description

Mohan Run is a third order stream which flows for 10.2 miles from its headwaters in Kersey until its confluence with Elk Creek east of Ridgway. The Mohan Run watershed drains 5.0 square miles and is positioned between the Gallagher Run and Daguscahonda Run watersheds. Pasture and hayfields account for the largest portion of land use, occupying about 9.2% of the total watershed area in the headwaters near Kersey (Homer et al., 2012). About 79% of the Mohan Run watershed is forested and owned by the PA Game Commission. After Mohan Run leaves the State Game Lands, it enters a privately owned dam, then flows another quarter of a mile until it confluences with Elk Creek.

The Mohan Run headwaters, segments MR01 and MR02, had small substrate size and were slightly embedded with silt and newly formed sand bars (Photo 1, 2). Riffles and pools were the dominant habitat types and both segments had plenty of boulders, undercut banks, and large woody debris for fish habitat. MR01 and MR02 averaged 6 and 8ft in wetted width, respectively, and confluence to make segment MR04. MR04 was larger and averaged about 20ft in wetted width. Substrate size was larger and the elevation change was greater, which resulted in a step-pool channel structure consisting mostly of boulders. MR04 ends as it confluence with MR03. MR03 was very similar to MR01 and MR02 in habitat structure, substrate composition, and habitat quality. The lower half of MR03 flowed through a u-shaped valley and was a step-pool channel until it met MR04 to form MR05. MR05 had an average wetted with of 20ft and had nearly even proportions of cobble (30%), boulder (20%), gravel (20%), and bedrock (25%). Streambanks in MR05 were less stable than upstream segments and many long, eroded banks were observed. MR05 lacked woody debris in the channel and was lower in gradient compared to upstream segments. Wild trout were observed in segments MR01 and MR05.

### Threats and Recommendations

Stream crossings from gas roads, powerlines, pipelines, and ATV trails present threats to streambank integrity and habitat quality along Mohan Run. Twelve crossings were observed along Mohan Run and the powerline crossed Mohan Run in segments MR01 and MR03 (Photo 6). Road and trail crossings created shallow, embedded sections of the stream channel which offered very little habitat for aquatic organisms. Large wood addition is recommended in the upper reaches of Mohan Run to prevent erosion and enhance fish habitat. Due to the remote location of the stream reaches, PA Fish and Boat habitat structure installation is likely unfeasible. However, mature hemlocks in the riparian areas could be cut and winched into the stream by hand to create overhead cover and create flow variability to reduce erosion along streambanks. Installing conveyor belt erosion strips on ATV and gas road stream crossings could further prevent erosion and sedimentation.

Recommendations for pipeline crossings throughout Mohan Run vary by situation (Photo 25, 27). Some of the pipelines cross well above bankfull height and allow unimpeded passage of stream material. Other crossings located within the regularly flooded channel have aggraded material overtime to create steps or have caused debris jams. All the aforementioned scenarios require different solutions. Pipeline crossings located above bankfull require no immediate action for the health of the stream or the integrity of the pipeline. Pipes located within the regularly flooded width of the stream channel, however, are more concerning. Pipes that have aggraded material to create steps within the stream appear to be stable and in no immediate danger of structural compromise. Pipes which have caused debris jams are more concerning. Ideally, the pipeline would be relocated to run subsurface or above bankfull height. Relocation is unfeasible, so the most practical option would be to routinely clear the debris from the pipeline. The pipeline experiences tension each time flood pulses push on material that has collected behind it. The tension could compromise the structural integrity of the pipe and cause a pollution event, if not maintained.

Sections of the stream which flowed through the powerline had little riparian vegetation and no canopy cover (Photo 6, 12). The absence of riparian vegetation throughout the powerline crossing exposes the stream channel to sun and can cause thermal barriers to fish passage (Petty et al., 2012), but woody debris could help shield the stream channel from sun and promote groundwater exchange to keep water temperatures cooler (Mutz, Kalbus, & Meinecke, 2007).

The Camp Kaelber Dam presents a barrier to aquatic organisms and material transport. Upstream of the dam we observed native Brook Trout that are likely a cutoff population (Photo 29). Isolated populations have reduced genetic variation which may make whole populations more susceptible to disease, ecosystem alteration, and genetic inbreeding. Additionally, headwater streams provide larger order streams with pulses of material necessary for ecosystem function (Vannote et al., 1980). The dam stores material and does not allow for sediment and detritus to pass downstream into Elk Creek. Because the Camp Kaelber dam prevents downstream transport of aquatic organisms, constructing a fish passage structure is recommended. A passage structure would help to reconnect the upstream fish population to the fish populations in Elk Creek. Fish passage could be accomplished using a variety of methods, such as a full width rock-ramp, partial width rock ramp, or bypass fishway. The most appropriate design for a fish passage structure would depend on the available area for construction and the overall slope of the stream. Additionally, the structure would need to be installed on private property and would require landowner agreement and support.

Photo 1. Silted section of MR01. Embeddedness was suboptimal in segment MR01.

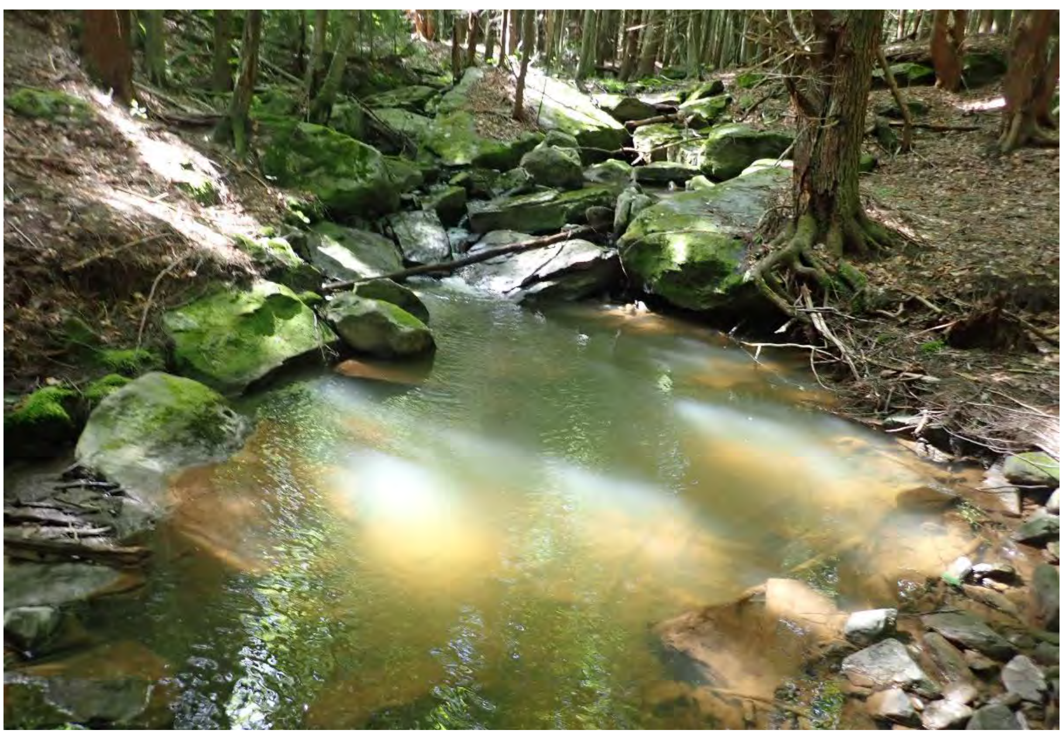


Photo 2. Pool habitat in MR01. This section of the stream was slightly turbid and embedded.

Photo 3. Location of wild trout observation in MR01. The overhanging bank provided great overhead cover.

Photo 4. End of MR01 looking upstream. The lower third of segment MR01 had plunge pool habitat with large substrate like pictured above.

Photo 5. V-shaped valley in segment MR02. Upstream MR02 is lower gradient, but elevation rapidly changes and the stream channel becomes confined in a v-shaped valley as it confluences with MR04.

Photo 6. Streambank erosion on powerline right-of-way. Riparian vegetation is sprayed and/or mowed throughout the right-of-way and differs from the vegetation naturally occurring upstream and downstream of the powerline.

Photo 7. ATV stream crossing along the powerline right-of-way in MR02. The crossing eroded and caused the stream substrate to become very embedded.

Photo 8. Beginning of segment MR03 where two small intermittent streams confluence.

Photo 9. Looking downstream from the beginning of segment MR03.

Photo 10. A portion of MR03 which flows subsurface beneath boulders.

Photo 11. ATV trail crossing on MR03. During assessment, the crossing was a barrier to fish passage due to being too shallow.

Photo 12. MR03 through the powerline right-of-way. Riparian vegetation is maintained with mowing and/or herbicides, thus the stream channel is exposed to daylight.

Photo 13. A portion of MR03 containing a bedrock shelf.

Photo 14. ATV crossing in MR03. Despite streambank erosion surrounding the crossing, the stream channel through the crossing was not deeply embedded.

Photo 15. Looking upstream at the confluence of MR03 (left) and MR04 (right).

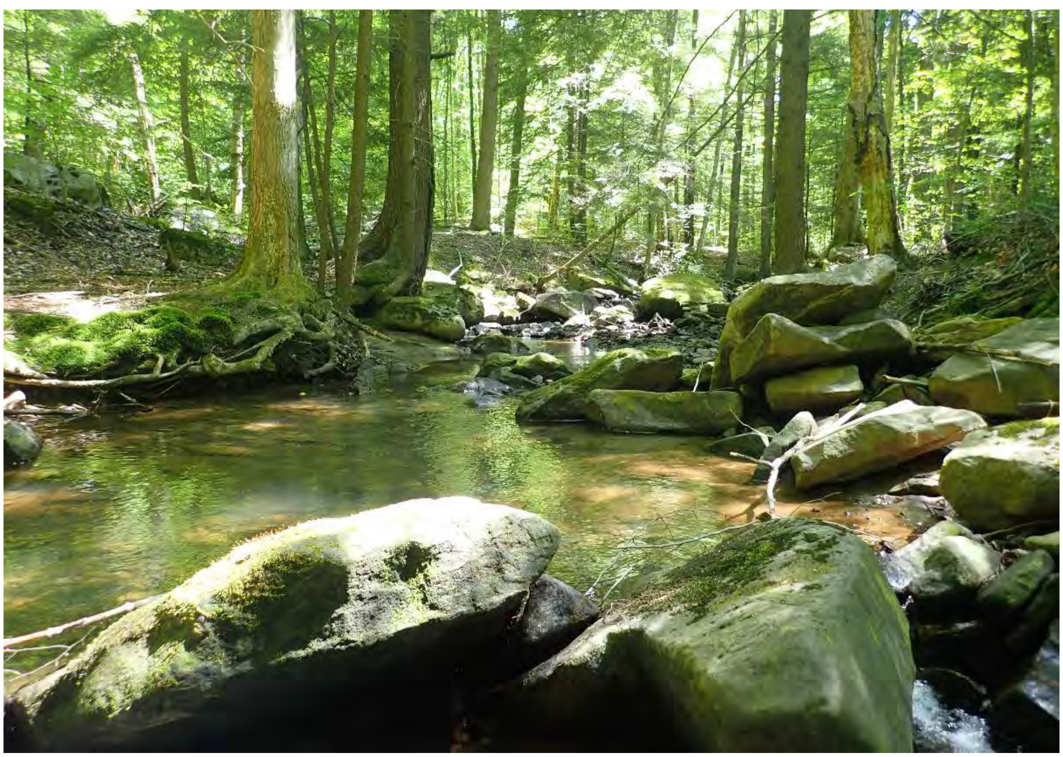


Photo 16. Looking upstream at the MR01 and MR02 confluence.

Photo 17. Looking downstream from the beginning of MR04.

Photo 18. Overhanging and undercut boulder habitat in MR04.

Photo 19. Debris jam in MR04 caused by a pipeline crossing.

Photo 20. Looking downstream from the beginning of segment MR05.

Photo 20. Point at which Mohan Run begins to transition from a high-gradient, step-pool channel structure to a low gradient stream channel with smaller substrate in MR05.

Photo 21. Eroded and undercut left bank in MR05.

Photo 22. Pool habitat in MR05 where trout were observed.

Photo 23. Long, bedrock bottom segment of MR05. This section of the stream channel has poor habitat quality.

Photo 24. Bedrock ledge in MR05.

Photo 25. Pipeline crossing in MR05. Sediment accumulated behind the pipe and created a step in the stream channel.

Photo 26. Eroded right bank in MR05.

Photo 27. Pipeline crossing the stream channel in MR05.

Photo 28. Looking upstream at Mohan Run from the Camp Kaelber Dam.

Photo 29. Looking downstream at the Camp Kaelber Dam from Mohan Run.

**Rocky Run**

**Description**

The Rocky Run headwaters begin from a wetland on LandVest property approximately 3 miles southeast of Johnsonburg (Photo 1). The headwaters were easy to access by a LandVest road which intersects Highway 219. The wetland is ponded behind a camp driveway, then flows for 3.2 miles until it confluences with Elk Creek a half mile west of the Store at Daguscahonda. Rocky run is a first order stream and is about 7ft wide, on average. The Rocky Run watershed drains 1.96 $mi^2$ and nearly 76% of the area is covered by deciduous forest (Homer et al., 2012). Maple and Beech were the dominant deciduous species within the riparian area. Evergreen forest, mixed forest, scrub/shrub vegetation, and woody wetlands account for the rest of the catchment landscape cover.

In the headwaters on LandVest property, sand was the dominant substrate, pools were the dominant habitat-type, and overall habitat quality was poor. The water was very dark, presumably from tannins due to decomposing plant material sourced from the wetland headwaters, as well as the mature forest canopy surrounding the stream (Photo 4). Floculation was observed in many of the pools throughout this reach, likely due to the high organic carbon content of the water due to the aforementioned tannins (Photo 2). Habitat quality improved as Rocky Run became more high-gradient and substrate size began to increase as it flowed from LandVest property to State Game Lands. By the time Rocky Run reached the Buhler property, it was a high gradient, boulder-dominated stream with step-pool structure (Photo 9). One 3 inch long native Brook Trout was observed during assessment. Pools accounted for an estimated 50% of the habitat in Rocky Run and were connected by shallow riffles and/or plunges. The best habitat for trout in Rocky Run were large boulders and undercut banks. Large woody debris was notably absent from the stream channel. Due to the riparian area being covered by mature forest, there was no vegetation overhanging the stream channel to provide cover. The pH just below the headwater wetland was 4.8 and increased to 6.4 as it confluence with Elk Creek. Specific conductivity was 31.9 µS/cm upstream and decreased to 21.0 µS/cm at the confluence with Elk Creek.

**Threats and Recommendations**

Few threats to habitat and water quality were observed along Rocky Run. Some incidences of small, naturally-occurring erosion were present, but the erosion was not cause for concern. A ford, bridge, and two culverts along Rocky Run created localized incidents of embeddedness and erosion. Of these manmade structures, the ford (Photo 8) and the railroad culvert (Photo 5-6) present the most significant threats to fish passage. During our assessment, both the ford and railroad culvert had flow and were passable, but it is likely that the structures become barriers to passage during low flows.

Replacing the ford with a more passage-friendly ford or culvert would be a potential habitat improvement project; however, the remote location of the ford would make such a project difficult. Overall, the replacement is low priority and aquatic organism passage could potentially be improved by adjusting the elevation of the crossing and replacing the limestone gravel with larger substrate to create deeper, more variable flows. The railroad culvert could be replaced with a more appropriately-sized culvert to improve fish passage. The current double box structure collects and aggrades sediment and debris at the inlet to create an approximately 1 foot tall drop between the stream bed and the bottom of the culvert.

Rocky Run habitat would benefit from large wood additions. The most efficient way to add large woody debris would be to use chop and drop methods, due to the lack of stream access for construction equipment. There were many mature hemlocks along the stream channel which would be ideal for large woody debris addition. The trees would provide overhead cover for aquatic organisms, trap and retain sediment (Montgomery et al., 1996), and create flow variability to reduce streambank erosion (Curran & Wohl, 2003).

Photo 1. Beginning of Rocky Run. Rocky Run headwaters begin as wetlands and flow through a culvert beneath a camp driveway.

Photo 2. Flocculation in Rocky Run. Water leaving the wetland is rich with dissolved organic carbon. Flocculation was frequently observed below riffles.


Photo 3. Sand and silt aggradation. Pools with sandy, silty substrate dominated instream habitat in the headwaters of Rocky Run.


Photo 4. Tannic water and poor habitat. Many sections of Rocky Run were bayou-like with slow flow, tannic water, and silty/embedded substrate. Sections like the photo above could benefit from large woody debris additions to provide habitat variability.


Photo 5. Inlet to the railroad culvert. The undersized, misaligned culvert collects sediment and debris at the inlet causing stream bed aggradation and creating a 1ft high inlet drop.


Photo 6.  Railroad culvert outlet. The structure has shallow water depth and likely dries during periods of low flow.

Photo 7. Mild erosion on the left bank.

Photo 8. Stream ford. Water depth was very shallow across the ford during our survey. During periods of low flow, the ford is likely unpassable for aquatic organisms.

Photo 9. Boulder plunge pools. Rocky Run gains gradient and sediment size increases as it approached Elk Creek. Boulder plunge pools pictured above are common habitats throughout Rocky Run.

**Seventy One Run**

**Description**

The Seventy One Run watershed encompasses 2.3 $mi^2$ of land north of Saint Marys. The headwaters begin on State Game Lands 25. The majority of the watershed is publicly accessible, with 78% of the land owned by the PA Game Commission. Seventy One Run flows for 4.1 miles, crosses underneath the railroad grade, and confluences with Elk Creek on the north side of Highway 120 near National Fuel. The watershed is dominated by 96% forest cover (Homer et al., 2012), which was observed to be composed of mostly Hemlock and Maple species within the riparian area during assessment. Low impact development in the form of gravel roads covers 1% of the watershed area.

Seventy One Run begins from a culvert under the State Game Lands road where the stream was about 3 feet in wetted width and intermittent for the first third of segment SV01. Substrate was mostly cobble and the stream was 100% shaded by mature forest. Landscape grade began to increase at segment SV02, where Seventy One Run transitioned into a 2$^{nd}$ order stream. SV02 was about 5ft in wetted width and dominated by cobble substrate throughout the segment. Seventy One Run substrate size decreases throughout SV03, where cobble, boulder, and gravel were present in nearly-equal proportions. SV03 substrate was moderately embedded by fines and had many depositional areas. Overall, fish habitat in Seventy One Run was rated as suboptimal due to siltation and embeddedness, a lack of significant large woody debris, undersized culverts, and streambank erosion. During the assessment of Seventy One Run, many native Brook Trout were observed in sections SEV02 and SEV03. Some trout in section SEV03 were estimated to be about 7 inches long. Water quality was normal on the day of sampling. Specific conductivity (µs/cm) ranged 22.2 to 29.7 and pH values were between 4.9 and 6.7.

**Threats and Recommendations**

Undersized culverts, which likely present barriers to fish passage, were observed during assessment of Seventy One Run. In addition to aquatic organism passage issues, the culverts caused aggradation and erosion which compromise the integrity of nearby roads and trails. We recommend removing or replacing barriers to aquatic organism passage to allow the native Brook Trout to freely migrate between the headwaters of Seventy One Run and Elk Creek. Replacing the culverts beneath the gravel road and the railroad is highly-encourage to prevent further sedimentation, erosion, and fish passage issues (Photo 5-6). If the gravel road can be decommissioned, the triple metal culvert (Photo 1) should be removed and the stream reach should be restored to an elevation and sediment composition similar to un-impacted areas of Seventy One Run.

During assessment, streambanks throughout Seventy One Run were observed to be moderately stable. According to WikiWatershed analysis, streambanks in Seventy One Run lose 5.13 tons of sediment annually. Installing large woody debris structures at the toe of steep, eroding banks is recommended to prevent further sedimentation in the stream. Seventy One Run would be an excellent candidate for large woody debris addition for fish habitat improvement and streambank stabilization because equipment required for LWD additions can be transported close to the stream in many areas due to gravel roads throughout the watershed; certain sections of the stream were shallow and over-widened and would benefit from habitat and flow variability; and the riparian area contained many mature, hemlock trees to use as material.


Photo 1. Inlet of triple culvert underneath gravel road. The culverts did not have the capacity to allow woody and inorganic debris to pass downstream and collect debris at the inlet. The debris, in this instance, created a barrier for water, debris, and aquatic organisms to pass.


Photo 2. Outlet of the triple culvert in Photo 1. The gravel road was eroding into the stream within the yellow circle. The undersized culvert caused water to pool, route around the stream crossing, and flow back into the stream at the circled location. The erosion was secured with rip-rap, though erosion continued to actively occur.

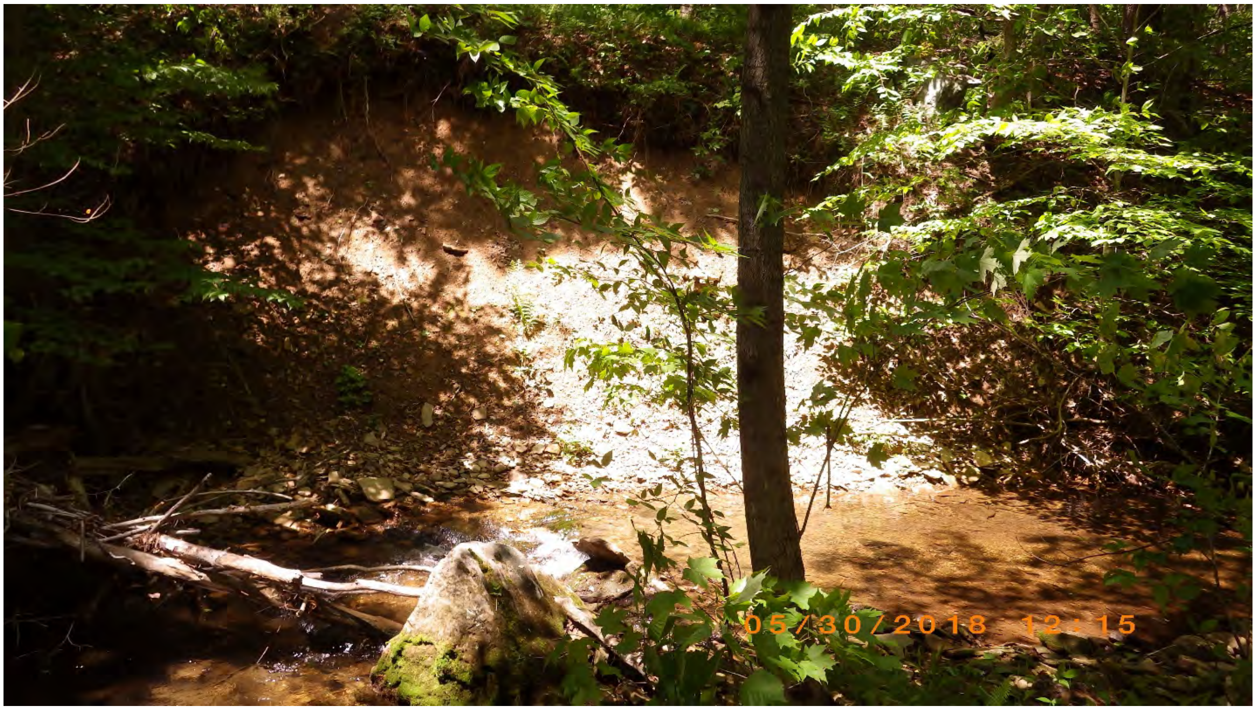


Photo 3. Steep, eroding bank. The above bank was approximately 12 feet tall. The erosion was caused by water leaving a relict trail and cutting down the slope.


Photo 4. Erosion from gravel road. Water leaving the gravel road removed sediment from the road surface and deposited it into the stream.

Photo 5. Inlet of railroad culvert. Sediment aggraded before the inlet, due to multiple, undersized culvert pipes which created a depositional area. The drop from the streambed to the bottom of the culvert pipes was estimated to be 1 foot high.

Photo 6. Outlet of railroad culvert in Photo 5. The drop from the middle pipe to the stream bottom was estimated to be 1 foot high. The inlet and outlet drops, in addition to the low water volume through the pipes, are barriers for aquatic organism p

**Silver Run**

**Description**

The headwaters of Silver Run are four, 1st order branches beginning at Taft Road in North Saint Marys. The headwaters flow south and conjoin to form two 2nd order branches of Silver Run which flow under the Keller and Silver Creek Roads (Photo 1). The 2nd order branches confluence just before crossing under Highway 255, near Joseph Road, and flow 1.5 miles before meeting Elk Creek. The Silver Run watershed drains 4.7 $mi^2$ of predominately forested (66.1%) landscape (Homer et al., 2012). Pasture and hay fields are the most common land use, comprising 19.5% of the watershed area. Nearly 8.5% of the watershed is developed with low-intensity and open space development.

We assessed the Western fork of the headwaters, where Silver Run is a 2nd order stream, beginning on Keller Road behind Suburban Building Center. SR01 was predominately boulder and sand substrate then transitioned to cobble/gravel/sand substrate before it ended at a manmade dam. The eastern fork of the Silver Run headwaters flowed through a beaver meadow before meeting with the Western fork below the manmade dam (Photo 3). Below the dam and confluence, Silver Run continues to resemble a bayou-like habitat, with slow-flowing water and sand/silt dominate substrate, until its confluence with another 2nd order tributary. We observed native Brook Trout as large as 6 inches long in SR01, but did not observe fish in any other stream sections.

As Silver Run began to flow towards Highway 255, elevation and habitat changed. SV03 was mostly cobble/gravel habitat and followed the bottom of a very steep right bank until it met Elk Creek. Streambanks were very unstable and eroded. Though Silver Run was assessed during normal flow, it was evident that the system is very flashy during periods of high flow. Stormwater runoff from Elk Highlands Hospital, Elk Haven Nursing Home, a suburban section of Saint Marys, and a portion of Elk County Catholic High School drain into Silver Creek and are likely the cause of flashy flows and bank instability. Due to the aforementioned stormwater stressors, instream habitat within SR03 was rated marginal. Specific conductivity ranged from 84.4 to 141 µS/cm and pH ranged from 6.7 to 7.4 from the headwaters to the mouth of Silver Run.

**Threats and Recommendations**

Erosion in SV03 was the largest threat to instream habitat (Photo 4). To protect the streambanks from further erosion, we recommend using large wood addition, PA Fish and Boat streambank stabilization structures, and stormwater best management practices. Streambanks along ATV trails could benefit from the addition of root wad deflectors to prevent streambanks from slumping into the channel. Additionally, adding large trees to the stream channel would help slow flow and prevent erosion while creating fish habitat (Curran & Wohl, 2003). To reduce stormwater impacts to Silver Run, developed sites should be evaluated for stormwater best management practices and retrofitted with appropriate stormwater controls. Streambanks in the lower, most developed portion of Silver Run are very unstable. WikiWatershed analysis supports our assessment findings. The largest loadings of sediment to Silver Run are sourced from streambanks in developed areas of the watershed. Each acre of development contributes 1,752 lbs of sediment to Silver Run annually.  Only nine percent of the sediment load is directly sourced from these developed lands. The majority of the sediment is from streambanks within developed areas of the watershed (1590 lbs/acre/year). During assessment, it appeared as though the hospital, nursing home, and residential areas did not have stormwater controls. Stormwater retrofits to these developed areas could greatly reduce erosion in Silver Run. Bioswales or detention basins could slow water, retain sediment, and reduce chemical inputs before water flows over the hill from developed areas to Silver Run (United States Environmental Protection Agency, 1983).

The manmade dam at the end section SR01 posed a threat to aquatic organism passage. Though a portion of the stream naturally routed around the dam, it may not be enough to allow fish passage, as we only observed fish upstream of the structure. Removing the dam and restoring natural stream grade and habitat could reconnect isolated trout populations within the headwaters. Increased flow velocities and pulses of sediment are concerns during dam removal; however, velocity and sediment pulse may not be a concern in this particular system. The manmade dam is already surrounded, upstream and downstream, by beaver meadows and wetlands which would mitigate flood pulses and store sediment. If removed, grade control structures should be installed to reconnect stream bottom elevations which have been altered over the years by sediment aggradation.

Photo 1. Silver Run Headwaters off Keller Road in North Saint Marys.

Photo 2. Debris jam in SR01 where wild trout were observed.

Photo 3. Manmade dam constructed from railroad ties.

Photo 4. Approximately 12ft high eroding left bank in SR01.

Photo 5. Undercut bank and pool habitat in SR01.

Photo 6. Debris jam and pool habitat in SR01.

Photo 7. Downstream view of the dam at the end of SR01.

Photo 8. Standing on the dam breast looking downstream in SR01.

Photo 9. Looking upstream at the top of the dam in SR01. Note water routes around the dam at the bottom left of the photo (yellow rectangle).

Photo 10. Beaver meadow located to the east of manmade concrete dam. The eastern headwaters of Silver Run end at this beaver dam.

Photo 11. The eastern headwaters which feed and flow through the beaver meadow in SR02.

Photo 12. The beaver dam before the confluence of the eastern and western headwaters of Silver Run in SR01.

Photo 13. The beginning of SR02 located downstream of the manmade and concrete dams.

Photo 14. The end of segment SR02 where another 2nd order tributary of Silver Run confluences.

Photo 15. Bridge inlet under Highway 255 near the intersection of Highway 255 and Joseph Road in SR03.

Photo 16. Left bank erosion and stormwater gulley from residential development from Cardinal Road in SR03.

Photo 17. Runoff from an ATV trail which enters SR03near the top of the photo.

Photo 18. Looking uphill at a gulley which receives stormwater from the nursing home and hospital and delivers it to SR03.

Photo 19. Standing on the ATV trail which parallels SR03.

Photo 20. Looking downstream at bridge where ATV trail crosses SR03. Abutments fell into the stream and caused a plunge pool beneath the bridge.

Photo 21. Looking upstream at the ATV trail bridge in SR03.

Photo 22. Looking downstream at the bridge under the railroad in SR03. The culvert is poorly aligned; however, the headwall successfully diverts all flow through the culvert. Dark coloration on the stones show where water flows during high flow (yellow line).

**Tencent Run**

**Description**

Tencent Run starts from a spring-fed farm pond/wetland near the South Paul Road and Cross Road intersection in Saint Marys. Tencent Run flows 1.89 miles until it confluences with Elk Creek behind the Product Assurance Services Inc. building on Highway 120. The majority of the watershed is forested (63%) and Hemlock and Beech trees were observed to be the dominant species in the riparian area (Homer et al., 2012). The most dominant land use in the watershed is farming. Hay fields and pasture cover 22% of the watershed area. Row crop agriculture and low impact development (houses, camps, and gravel roads) both cover about 7% of the watershed area.

Tencent Run is a 1st order stream from headwaters until its confluence with Elk Creek. Average wetted width of the channel was about 6ft and substrate was an even mix of cobble and gravel. Habitat in Tencent Run was mostly riffle with small pools present on stream bends. Many of the riffles were very long and shallow. There were many sand and silt bars throughout the assessed segments and pool habitats were moderately embedded. Average overall habitat score was rated as optimal (score: 17/20) and undercut banks, debris jams, and large woody debris were observed throughout the assessed sections. The lowest scoring habitat variable was velocity/depth regimes in both assessed sections. Tencent Run was missing fast flowing, deep waters which caused the velocity/depth regime scores to be rated as suboptimal. In section TC01, embeddedness also scored suboptimal (11/20). The pH ranged from 7.6 to 7.9 from the headwaters to the mouth, respectively. Specific conductivity was elevated at 117.6 and 242 µs/cm from the headwaters to the mouth, respectively. We observed many native Brook Trout, 1 to 7 inches long, in the assessed sections of Tencent Run.

**Threats and Recommendations**

The greatest land use threats to Tencent Run are the hay fields, pastures, and row crops throughout the watershed. Although Tencent Run has overall optimal fish habitat, the water quality and sedimentation resulting from these land use practices could impact fish populations. Row crop only occupies 7% of the watershed area and WikiWatershed analysis predicts it contributes the greatest loads of sediment (12 tons/year) and nitrogen (158.1 lbs/year) to Tencent Run. Hay fields and pasture also contribute 11.3 tons of sediment to Tencent Run annually. The threats from the houses, gravel roads, and camps present negligible threats in comparison the farming activities; however, erosion and sedimentation from gravel roads, ATV trails, and gas pipelines was observed during assessment. Potential sewage and manure pollution were observed in TC01. Water was slightly discolored, had an odor, and had elevated specific conductivity (242 µS/cm) at the top of TC01 immediately downstream from a farm.

Threats to Tencent Run could be mitigated through the use of common best management practices. Maintaining vegetated riparian buffers between the stream and residential areas, gravel roads, and farmed fields is recommended and crucial to maintaining the integrity of fish habitat of Tencent Run. Tencent Run is a first-order stream and has naturally low water levels. Vegetation surrounding the stream channel helps prevent water loss due to evaporation and consequently shades the stream and keeps it a suitable temperature for the native Brook Trout. Vegetated buffers will also help assimilate nutrients from farm runoff and prevent sediment from entering the stream channel (Naiman & Decamps, 1997). No-till and cover crop farming practices are recommended to reduce sediment and nutrient pollution to Tencent Run. As per WikiWateshed estimates, replacing conventionally farmed fields with cover crops and no-till plowing methods would reduce sediment loads to Tencent Run by 25.3% (7.8 tons) annually.

Photo 1. Eroding bank on an outside bend in TC02. Adding large woody debris in this section of the stream would help slow and redirect water to reduce erosion and downstream sedimentation.

Photo 2. ATV trail (yellow circle) beside the stream channel. Sediment washed into the stream channel from the trail and caused embeddedness in the pool beneath the undercut log.

Photo 3. Culvert at the end of TC02 beneath Joseph Road. The culvert was undersized. From the dirt residue on the pipe, it is obvious that the stream overtops the culvert during high flow. Aquatic organisms, greater water volume, and material could pass more efficiently through the culvert if it were to be replaced with an appropriately-sized structure.

Photo 4. Gas pipeline (yellow circle) and ATV crossing. The trail was likely a gas pipeline that is currently used as an ATV trail. Sediment from the trail washed into the stream channel and caused sedimentation. Additionally, debris caught on the pipeline forced water to route around the pipeline during high flows, thus further contributing to the trail erosion. Cobble placed in the stream channel helped reduced sedimentation from ATV crossings; however, the cobble also created an aquatic organism passage issue at normal flow.

Photo 5. Example of fish habitat impaired by sedimentation and siltation in TC01. Depositional areas in TC01 were 25-50% embedded. Lack of interstitial spaces created poor macroinvertebrate habitat and siltation could potentially harm fish eggs.

**Water Tank Run**

**Description**

Water Tank Run is a Class A trout stream which begins on State Game Lands 25 about 4 miles northwest of Saint Marys City. The headwaters begin just below the Game Commission and gas company road that intersects Highway 255 north of Fernwood Road. Water Tank Run flows 3.1 miles until its enters Elk Creek a half mile north of the National Fuel Building off of Highway 120. The Water Tank basin is located east of Seventy One Run and west of the Tencent Run. Water Tank Run is a second order stream when it enters Elk Creek and has an average stream width of 6.5 feet. Deciduous forest (49.9%) is the dominant land cover, followed by grassland (9.9%) and evergreen forest (9.3%) (Homer et al., 2012). During assessment, Beech and Hemlock were the most commonly observed tree species within the riparian area. In the lower section of Water Tank Run, willows were dominant riparian area cover. Non-native invasive Multiflora rose was observed in the riparian area, as well. Pasture and hay fields are the dominant land use (6.3%).

Pool and riffle habitats were abundant throughout both sections of Water Tank Run and many overhanging boulders, undercut banks, and pools were observed in WT01 (Photos 1-3). Closer to where the stream met Elk Creek, habitat became more shallow and substrate size was smaller and more embedded. The change in habitat was likely due to debris catching in the railroad culvert and causing water to slow and pools to fill with substrate. Water Tank Run flows through a relic wetland/beaver meadow as it meets Elk Creek. Habitat in the relic wetland is poor as it is shallow, embedded, and void of cover. The pH was 7.1 at the beginning of WT01 and 7.3 at the confluence of Water Tank Run and Elk Creek. Specific conductivity ranged from 32.4 to 33.7 µS/cm throughout the assessed sections. True to its Class A designation, Water Tank Run harbored many Brook Trout of varying size classes throughout the assessed sections. On average, Water Tank Run habitat was rated as optimal (17.7/20).

**Threats and Recommendations**

A culvert, stream ford, and riparian ATV trail (Photo 4) were observed to be the largest threats to Water Tank Run. The ford and ATV trail were on private property, rarely used, and did not appear to significantly impact the stream during assessment. Among the observed threats, the culvert beneath the railroad was the most concerning (Photo 5). The culvert had two pipes containing inlet drops, outlet perches, and low water levels which could act as barriers to fish passage between Elk Creek and Water Tank Run during certain water levels, thus affecting resource availability and population genetics. The poor habitat in the relic wetland on the outlet of the railroad culvert makes aquatic organism passage more challenging. Trout were stranded in the culvert tail pools during assessment.

Removing or replacing the culvert beneath the railroad could greatly benefit the aquatic connectivity between Water Tank Run and Elk Creek. Promoting unimpeded ecosystem connectivity between Elk Creek, other tributaries, and Water Tank Run would allow trout populations to interbreed. Water Tank Run would also bee woody an excellent stream to provide refuge to trout travelling through Elk Creek if trout could move upstream of the culvert. An appropriately sized and aligned culvert would also increase water capacity and help transport sediment further downstream instead of creating a depositional area. These changes to hydrology at the end of Water Tank Run could improve pool habitat, reduce embeddedness, and create a navigable channel through the wetland to Elk Creek.

Photo 1. Woody debris in WT01. Without woody debris, this section of Water Tank Run would likely be a long, shallow riffle. The woody debris creates habitat variability for aquatic organisms.

Photo 2. Exposed roots and woody debris in WT01. The debris, collected on the outside bend in a pool, prevented erosion and provided excellent fish habitat. Native Brook Trout were observed swimming into the woody debris during assessment.

Photo 3. Overhanging boulders in WT01. Native Brook Trout were observed swimming into the small pool habitats beneath the boulders.

Photo 4. ATV trail on private property in WT01. Though the trail crosses the stream, it appeared to have little impact on stream habitat during assessment. The trail appears to be infrequently used.

Photo 5. Outlet of the railroad culvert. The pipe on the left was nearly dry and the pipe on the right had low flow during assessment. Trout were observed to be stranded in the outlet plunge pools. In August, the plunge pools were the only available refuge between Elk Creek and the rail road culvert, as the stream in between was formerly a beaver pond with shallow, warm water.

Photo 6. Looking down at the inlet of the railroad culvert. Stakes were placed at the inlet to prevent woody debris from entering and passing through the culvert. Though there was no debris jam observed during assessment, it was evident that debris collects at this point and is removed regularly (likely by the railroad) due to deposition and a drop to the pipe inlet.

## Section 4. Elk Creek Macroinvertebrates

### Methods

Macroinvertebrates were collected August 23-24, 2019 using semi-quantitative methods developed by DEP. We used a 500µm D-frame net to sample six locations in riffles within a 100m consecutive stream reach. Each sample was collected by kicking a 1 $m^2$ area above the kick net for 30 seconds to ensure sampling effort was uniform among sub-samples. Macroinvertebrates were preserved with 70% ethanol in pollination bags and sorted at the Elk County Conservation District. The six samples from each stream were combined to create one composite sample. One composite sample from each tributary, excluding Laurel Run, and three samples from Elk Creek (upper, middle, and lower) were shipped to EcoAnalysts lab where samples were then identified to the genus level. Shannon-Weaver Diversity ($\log_{10}$)

$$Shannon - Weaver\ H = \sum_{i=1}^{s} p_i \log{(p_i)}$$

$p_i$ = proportion (n/N) of individuals of one particular genus found (n) divided by the total number of individuals found (N) in the sample

s = number of genera in the sample

and Hilsenhoff Biotic Index scores

$$HBI = \frac{\sum n_i \text{ x } a_i}{N}$$

n = number of individuals in taxa *i*

a = tolerance value of taxa *i*

N = total number of individuals in sample

were calculated using the data provided by EcoAnalysts. Shannon-Weaver Diversity, HBI scores, percent EPT taxa, species richness, and percent composition of functional feeding groups were correlated to land use/land cover metrics using Pearson correlations and evaluate for statistical significance using an alpha level of 0.05.

### Results

A total of 5693 macroinvertebrates were collected among the 13 locations within the Elk Creek Watershed. The average abundance for the Elk Creek and its tributaries was about 406 individuals. Silver Run had the highest abundance with a total of 1287 individuals. The upstream Elk Creek location had the fewest individuals (abundance = 7). The average abundance of EPT taxa for Elk Creek and its tributaries was about 232 individuals. EPT taxa represent more sensitive macroinvertebrate families (e.g. Ephemeroptera, Plecoptera, and Trichoptera which are Mayflies, Stoneflies, and Caddisflies, respectively). Gallagher Run had the highest abundance of EPT taxa (abundance = 304). Excluding the upstream Elk Creek sampling location due to low total abundance, Daguscahonda Run had the lowest abundance of EPT taxa (abundance = 49). Chironomidae (Midge) and Leuctra species (Rolled-wing Stoneflies) were each the most dominant taxa in four streams. Stream EPT taxa composition (%) was positively correlated with percent forest cover within watersheds (Pearson r = 0.73). EPT taxa composition was negatively correlated with both development (% area) (Pearson r = -0.69, p = 0.006) and pasture/ hay field (% area) use within watersheds (Pearson r = -0.67, p =0.01).

On average, Elk Creek and its tributaries contained about 28 different species of macroinvertebrates. Mohan Run had the highest species richness (42 species). Excluding the upstream Elk Creek sampling location due to few individuals, the middle sampling location of Elk Creek had the lowest species richness (20 species). Species richness among Elk Creek and its tributaries was negatively correlated with watershed development (% area) (Pearson r = -0.68, p =0.01) and positively associated with forested area (%) in watersheds (Pearson r = 0.54, p =0.05).

Gathering taxa were the dominant functional feeding group in 6 of the 13 sampling locations and made up an average of 32% of the taxa among streams. The next highest dominant functional feeding group was filtering taxa, which composed an average of 25% percent of the taxa for each sampling location. Overall, scrapers comprised the lowest proportion of individuals (6% of taxa) among streams. Predator taxa were dominant in the upstream and middle Elk Creek sampling locations. Water Tank Run was composed of equal proportions of gathering and shredding taxa.

Species diversity, rated using Shannon-Weaver H ($\log_{10}$) measurements, ranged from 0.42 to 1.26 among sampling locations. Using the Shannon-Weaver H value, high H values are representative of more diverse macroinvertebrate communities. A macroinvertebrate community lacking diversity would have an H score of 0. The upstream Elk Creek location had the lowest and Mohan Run had the highest species diversity. The average Shannon-Weaver H value was 1.02 among streams. Diversity was negatively correlated with percent development within watersheds (Pearson r = -0.60, p = 0.02) and positively associated with forest cover in watersheds (Pearson r = 0.55, p = 0.04).

Hilsenhoff Biotic Index (HBI) scores were calculated to assess water quality of each sampling location. The Hilsenhoff Biotic Index measures the overall tolerance of macroinvertebrate communities to organic pollution and gives an estimate of water quality. The scores range from 0 to 10 with a score of 10 indicating the community most tolerant to organic pollution. HBI scores ranged from 2.42 (Water Tank Run, excellent water quality) to 5.29 (Upstream Elk Creek, fair water quality) among sampling locations. The average HBI score among Elk Creek and its tributaries was 3.72, which is rated as excellent water quality. Higher water quality scores were associated with forested cover among watersheds (Pearson r = -0.94, p < 0.01). Lower water quality scores were associated with developed area (Pearson r = 0.81, p < 0.01) and hay and pasture field land use (Pearson r = 0.62, p = 0.02).

**Discussion**

Metrics of diversity, richness, sensitivity, and water quality were significantly correlated with land use (e.g. pasture/hay fields, development) and land cover (e.g. forest). The significant correlations indicate the metrics and land use/cover are related. The correlations do not imply causation, however. For example, because macroinvertebrate species richness is greater in less developed watersheds, it does not mean the developed area directly influences species richness. Rather, common urban stressors like water pollution and flashier hydrographs could be the cause of decline in species richness. In order to address water quality impairment and sustain species diversity and richness, specific stressors associated with each land use/cover type should be addressed. The Elk Creek Coldwater Conservation Plan identifies land use stressors and recommends mitigation and best management practices to reduce physical, chemical, and biological impacts to each stream within the Elk Creek Watershed.

Functional feeding group (FFG) composition among watersheds did not produce significant correlations with land use/cover metrics. However, FFG composition highlights how energy is obtained and processed in a stream ecosystem and is explained by the River Continuum Concept (RCC) (Vannote et al., 1980). Functional feeding is the method by which a macroinvertebrate obtains its food. Gathering, shredding, and filtering taxa should comprise the majority of the macroinvertebrate community in headwater streams. Headwater streams are small in width, and thus, strongly influenced by their riparian zones. The trees in the riparian area shade the stream to reduce primary production (e.g. algae growth) and contribute detritus (e.g. leaves) to the stream channel; therefore, macroinvertebrates within headwater streams must be adapted to feed on the on detritus inputs. As headwater streams confluence and drainage area increases, stream width increases and alters energy dynamics within the stream. Wider streams (like 3rd through 5th order streams) are not as heavily-influenced by riparian vegetation and shading, thus sunlight reaches the stream channel and fuels primary production. Due to the increase in primary production, scraping taxa will be present to feed on algae. Shredding taxa will be less abundant due to decreased detrital inputs. Predator composition should remain relatively even throughout stream orders, as the food source for predators will not change. Altered FFG composition can be an indicator of land use and stream channel alterations.

Tributaries to Elk Creek fit the assumptions of the River Continuum Concept, but upstream and middle Elk Creek macroinvertebrate samples deviate. Each sampled tributary was composed mostly of shredding, filtering, or gathering taxa. The FFG composition indicates the small-order tributaries are heavily-linked to their riparian areas and receiving a significant amount of energy from detrital inputs (Vannote et al., 1980). Elk Creek is a 3rd order stream where the upstream macroinvertebrate sample was collected, so the FFG composition should be similar to the headwater tributaries; however, upstream Elk Creek FFG composition was nearly evenly split between filtering and predator taxa. It is important to note that the upstream Elk Creek sample only contained 7 individuals, so the sample may not accurately represent the macroinvertebrate community in upstream Elk Creek. Middle Elk Creek was mostly composed of filterers (31%) and gatherers (27%), but predators, contrary to RCC predictions, were the most abundant (36% composition) FFG in middle Elk Creek and compared to the other samples collected. Downstream Elk Creek fits the 4th order FFG predictions of the RCC and was comprised of mostly filtering, gathering, and scraping taxa. Because downstream Elk Creek is larger in size, the stream is able to support more primary production and, subsequently, support taxa which feed primarily on algae through scraping mechanisms. Downstream Elk Creek had the largest composition of scraping taxa relative to all other sampling locations, which supports RCC predictions.

Conclusion

Overall, Elk Creek Watershed macroinvertebrate metrics were strongly-linked to alterations in land use and reaffirm the importance of implementing the restoration recommendations previously highlighted in this plan. The macroinvertebrate analyses from this study should be used as baseline data to track the health of Elk Creek and its tributaries moving forward. Additionally, as restoration projects are completed in the Elk Creek Watershed, macroinvertebrate community data should be used as a metric of restoration success.

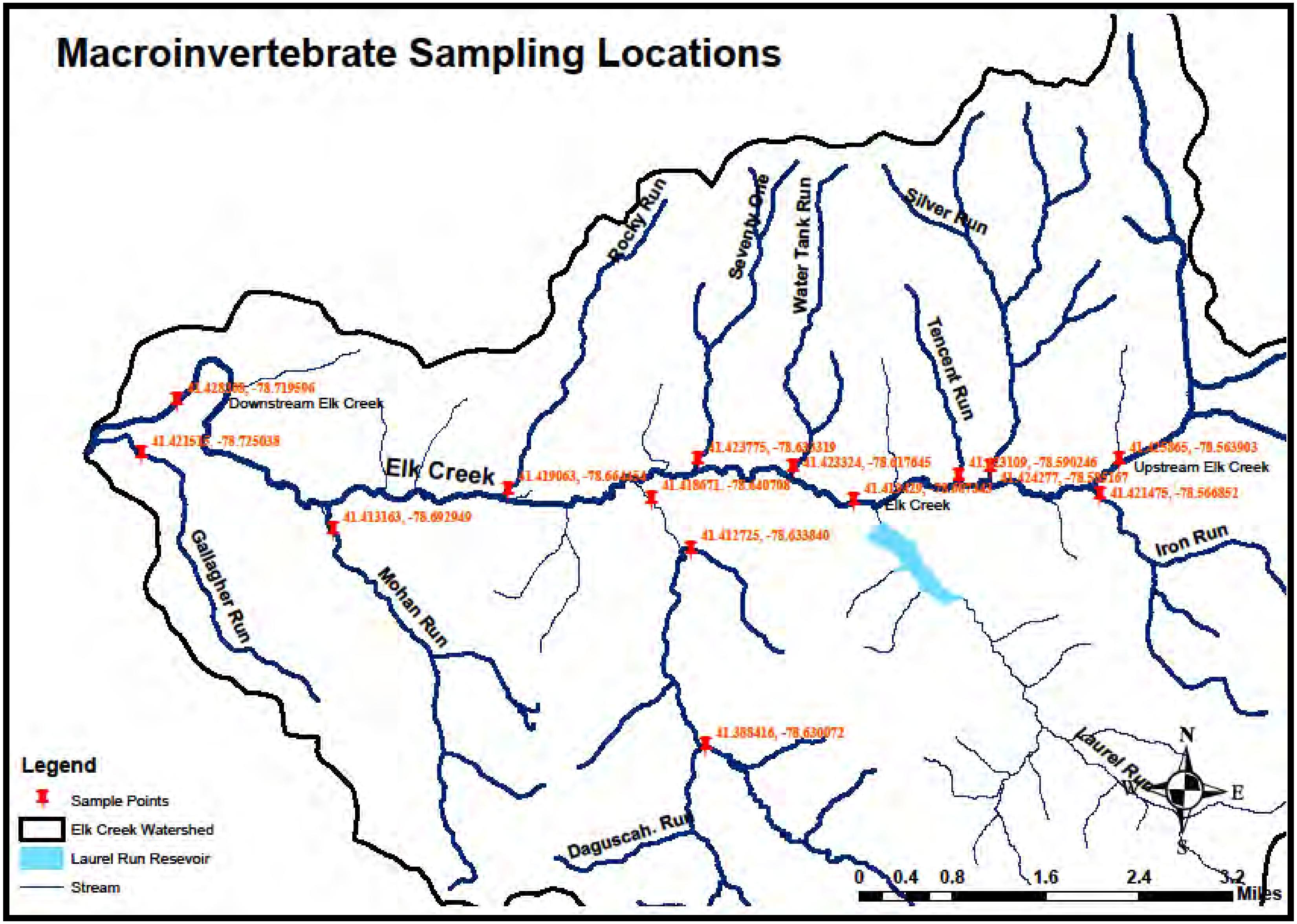



Figure 12. Macroinvertebrate sampling locations in Elk Creek and tributaries.

**Macroinvertebrate Figures**

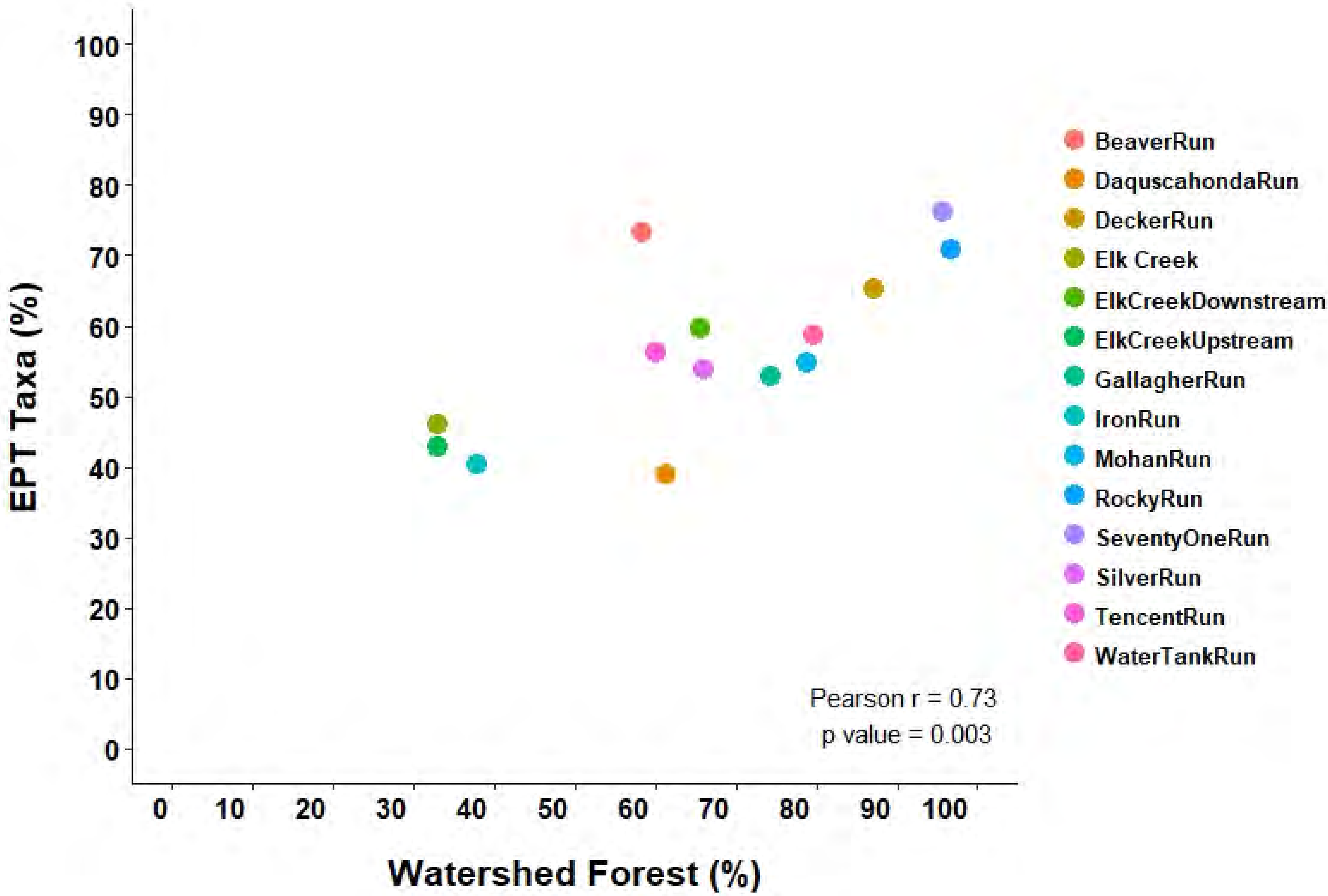



Figure 13. Percent EPT taxa was negatively associated with watershed development (% cover) within watersheds.

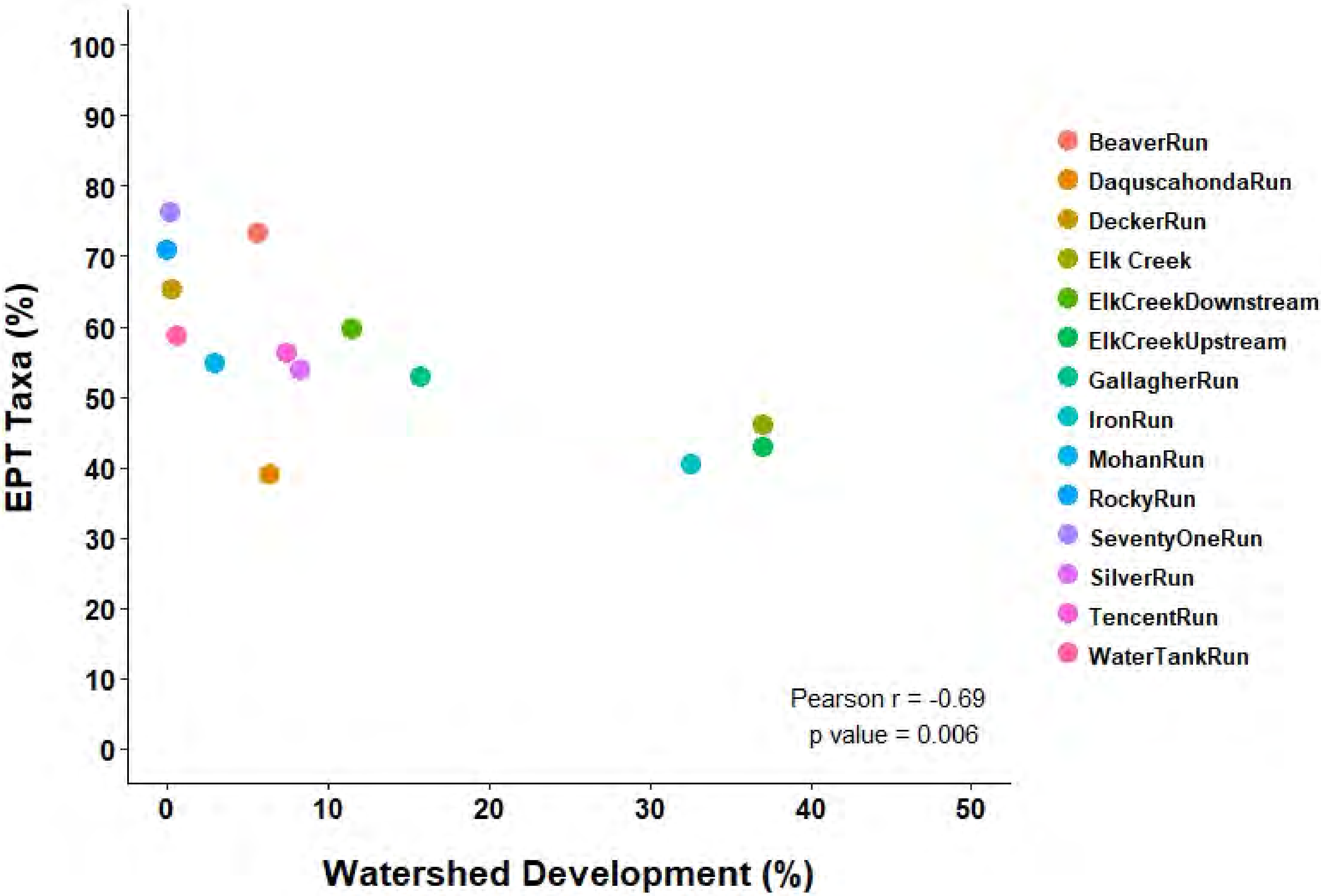
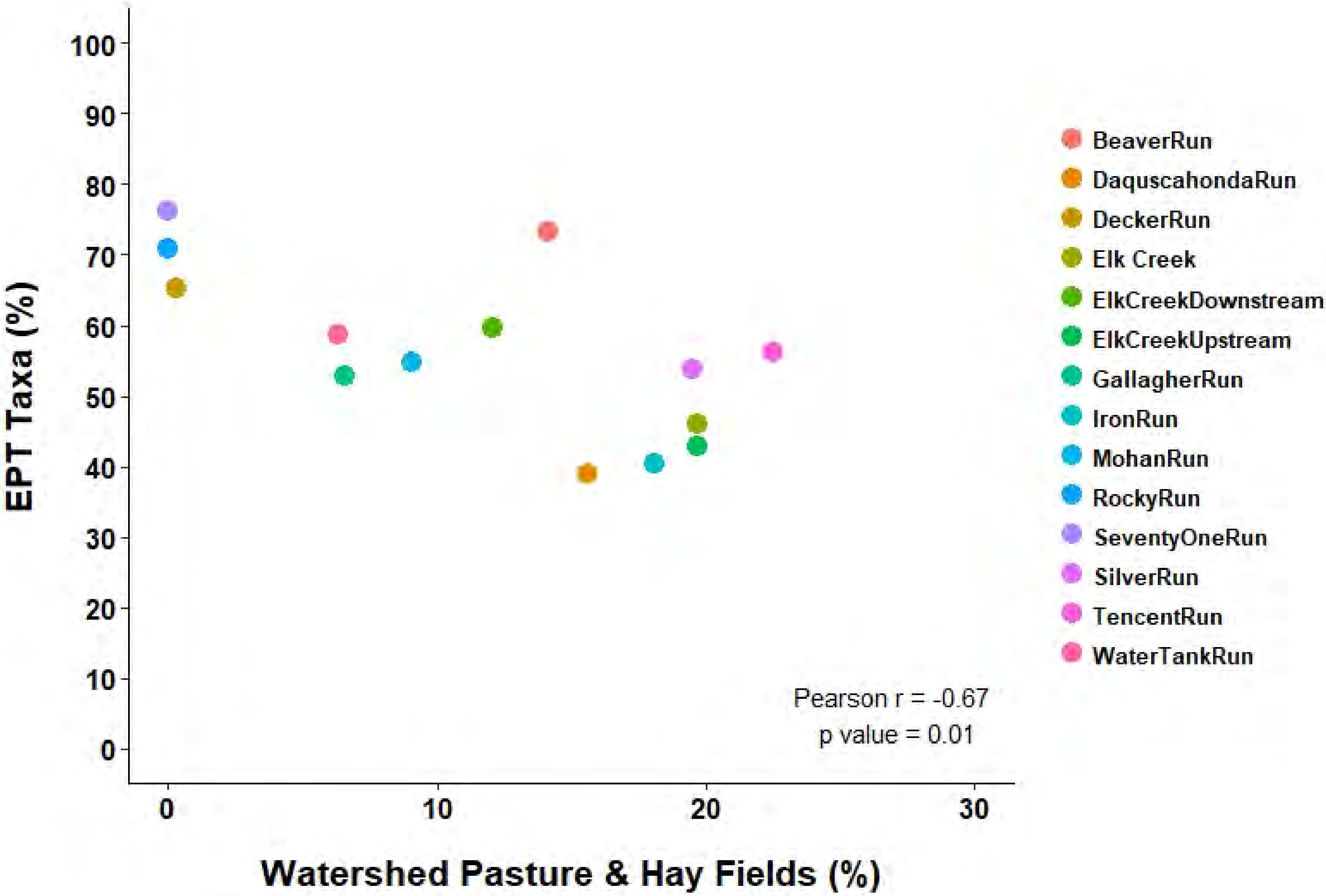
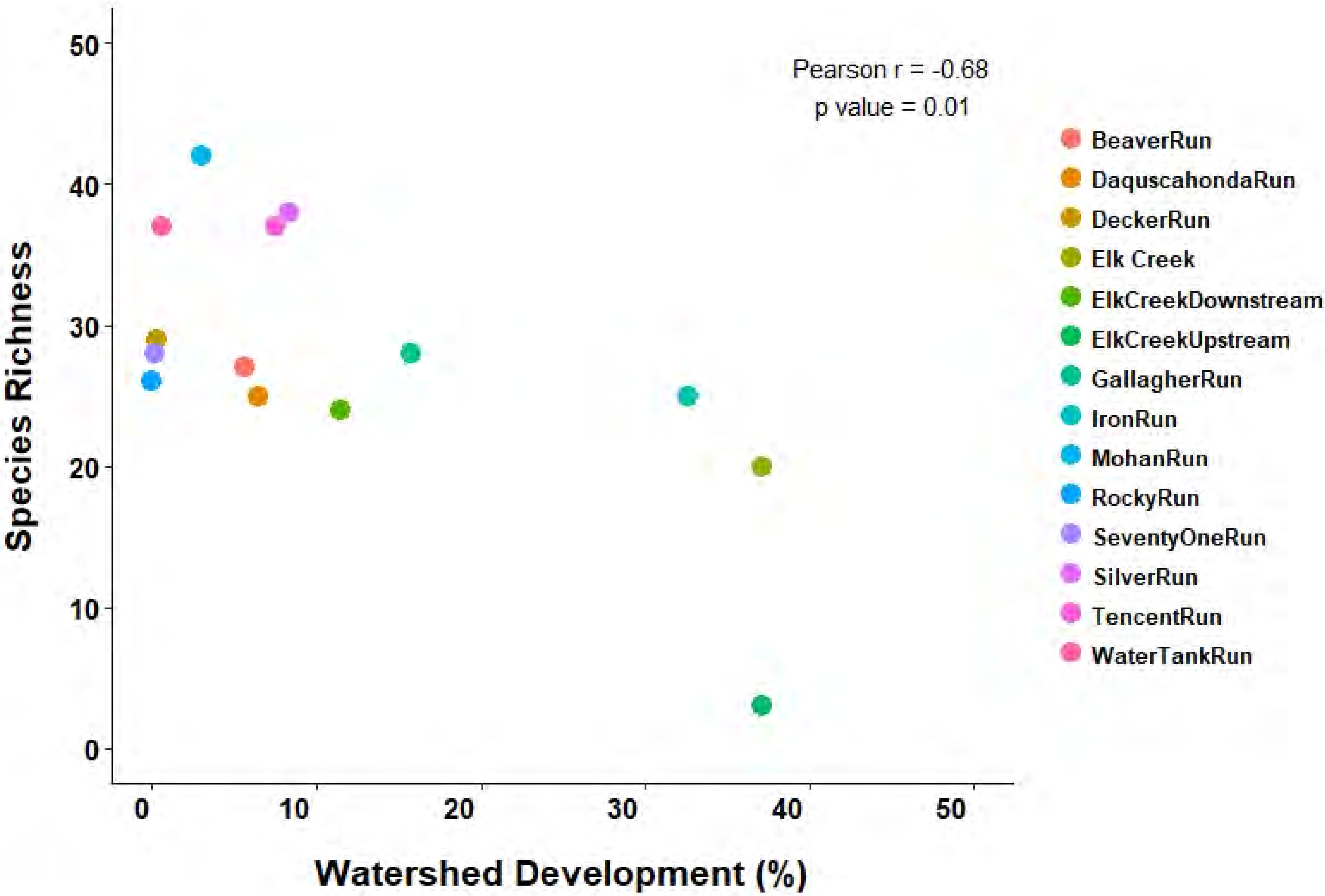
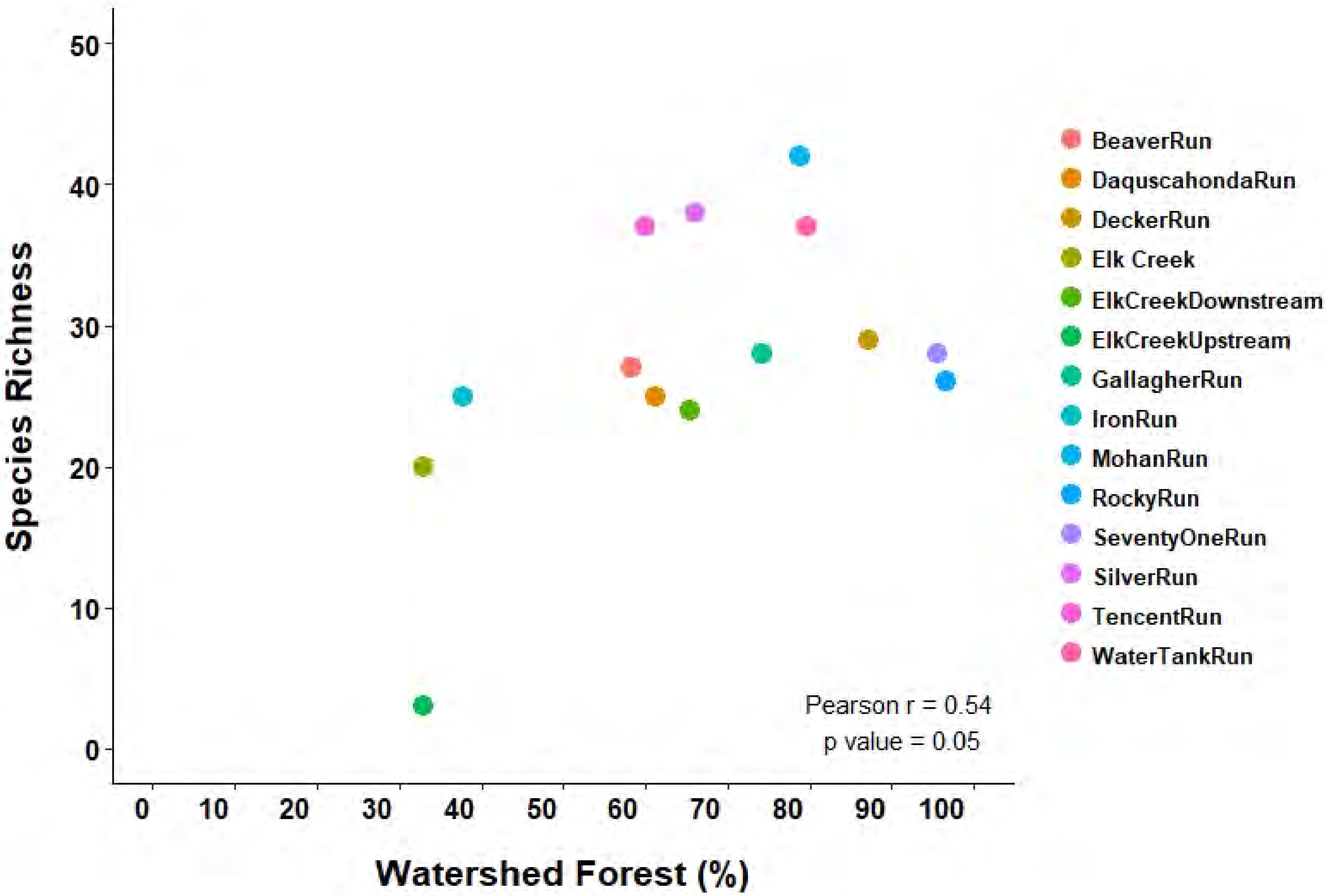



Figure 14. Percent EPT taxa was positively associated with forested area (% cover) in watersheds.



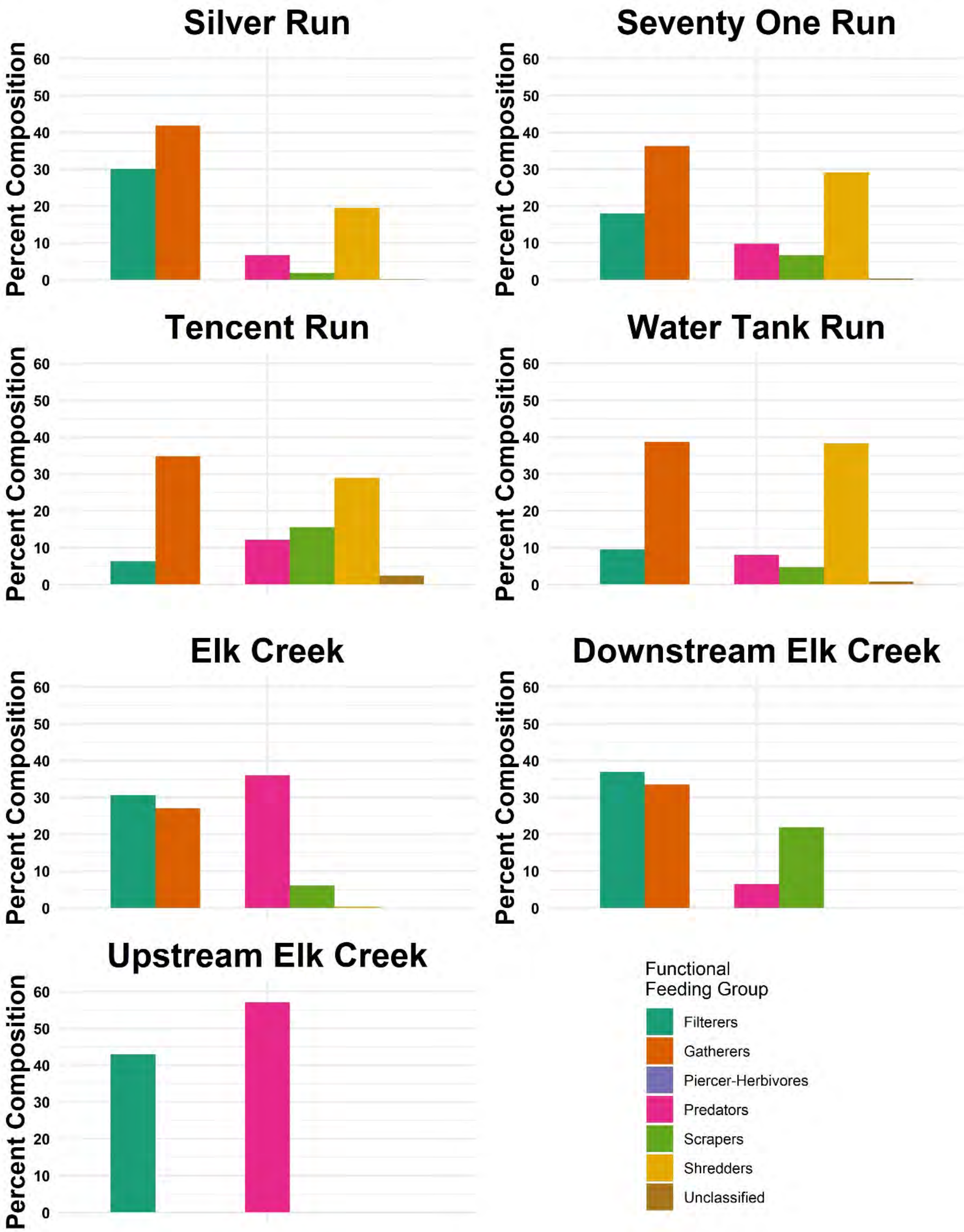
EPT Taxa (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
Watershed Pasture & Hay Fields (%)
Pearson r = -0.67
p value = 0.01
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun

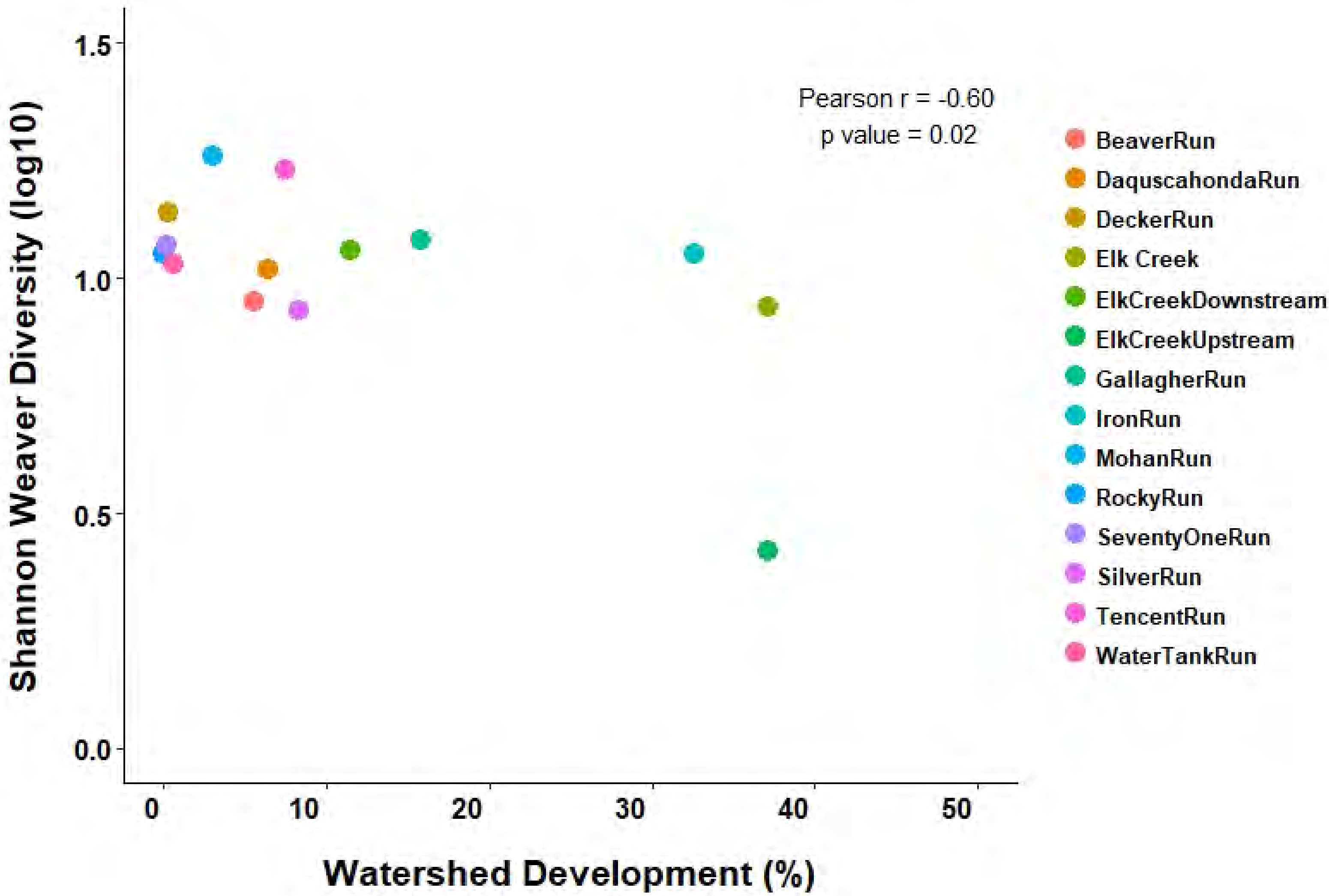

Pearson r = -0.68
p value = 0.01
Species Richness
Watershed Development (%)
0
10
20
30
40
50
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun



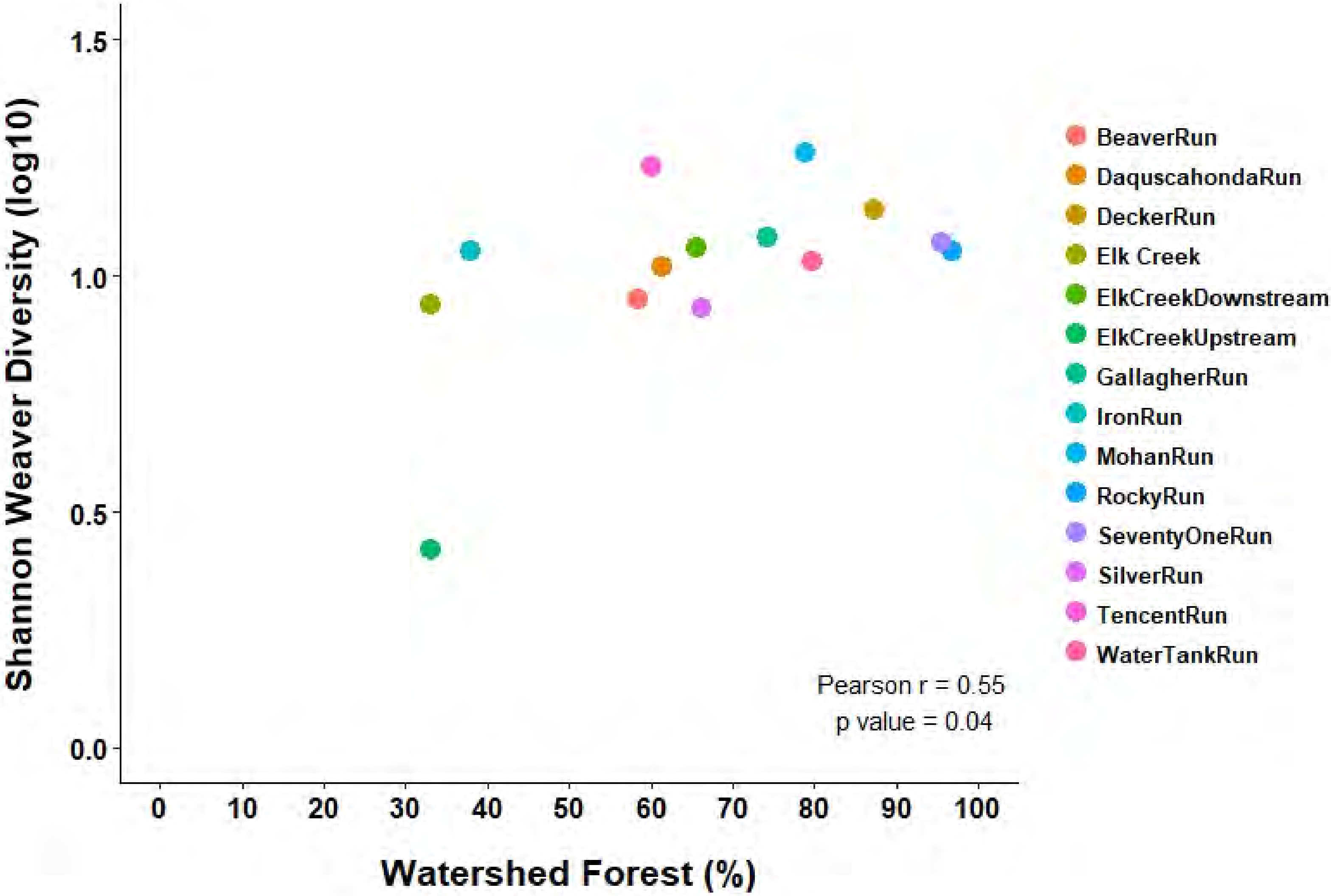
Species Richness
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
Watershed Forest (%)
Pearson r = 0.54
p value = 0.05
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun

Beaver Run
Daguscahonda Run
Decker Run
Gallagher Run
Iron Run
Mohan Run
Rocky Run
Percent Composition
0
10
20
30
40
50
60
Functional Feeding Group
Filterers
Gatherers
Piercer-Herbivores
Predators
Scrapers
Shredders
Unclassified

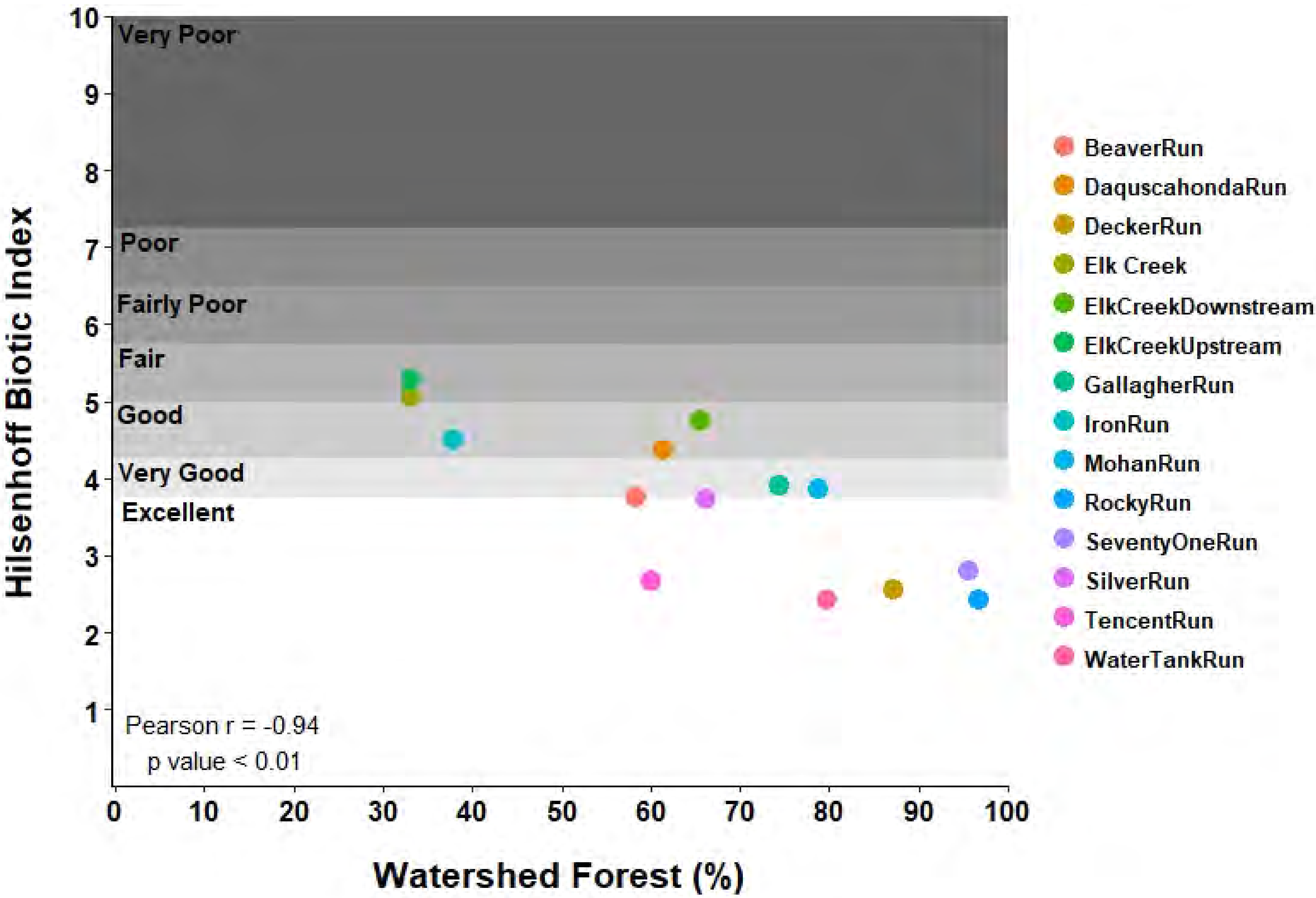

Silver Run
Seventy One Run
Tencent Run
Water Tank Run
Elk Creek
Downstream Elk Creek
Upstream Elk Creek
Percent Composition
0
10
20
30
40
50
60
Functional
Feeding Group
Filterers
Gatherers
Piercer-Herbivores
Predators
Scrapers
Shredders
Unclassified

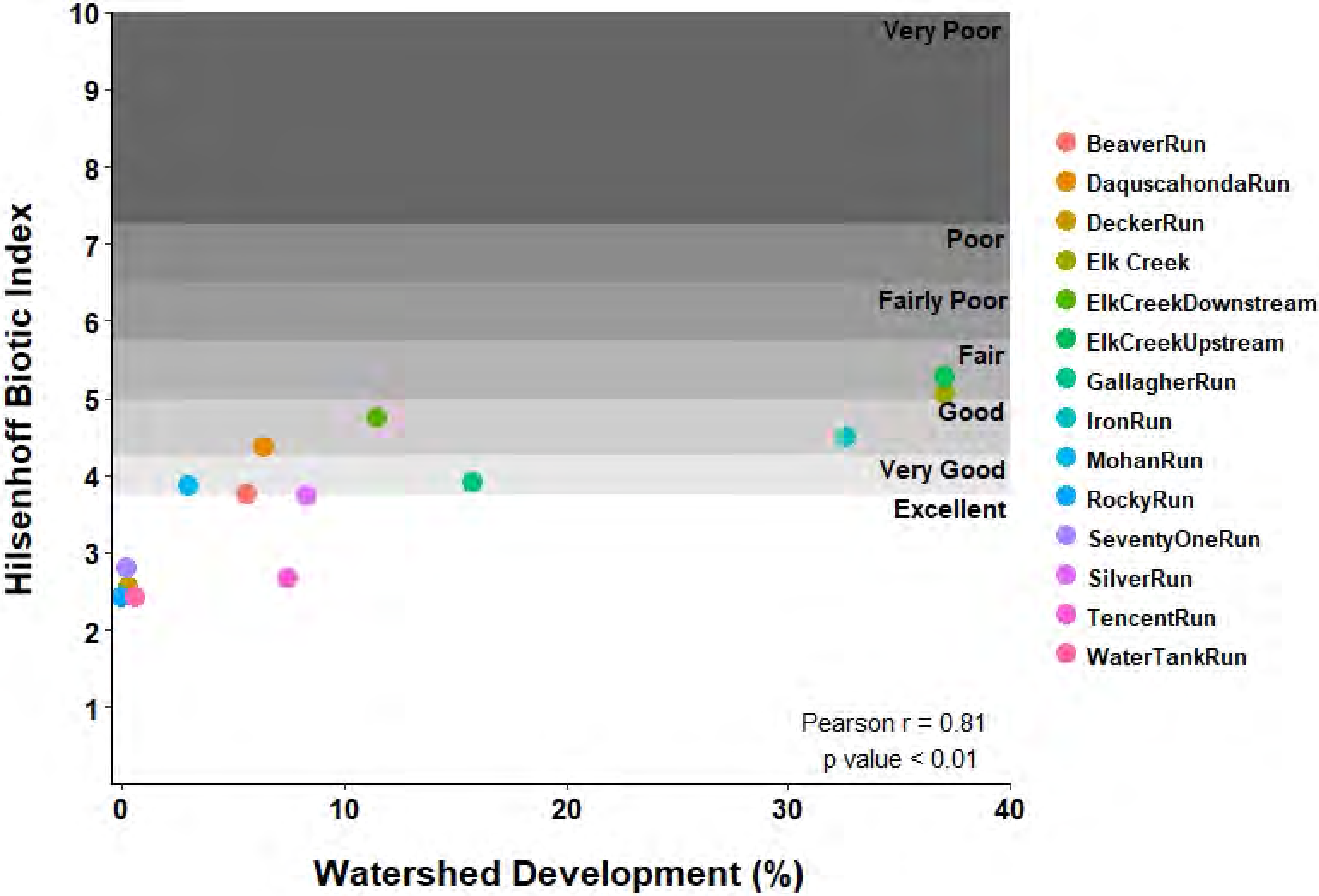


Pearson r = -0.60
p value = 0.02
Shannon Weaver Diversity (log10)
1.5
1.0
0.5
0.0
0
10
20
30
40
50
Watershed Development (%)
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun

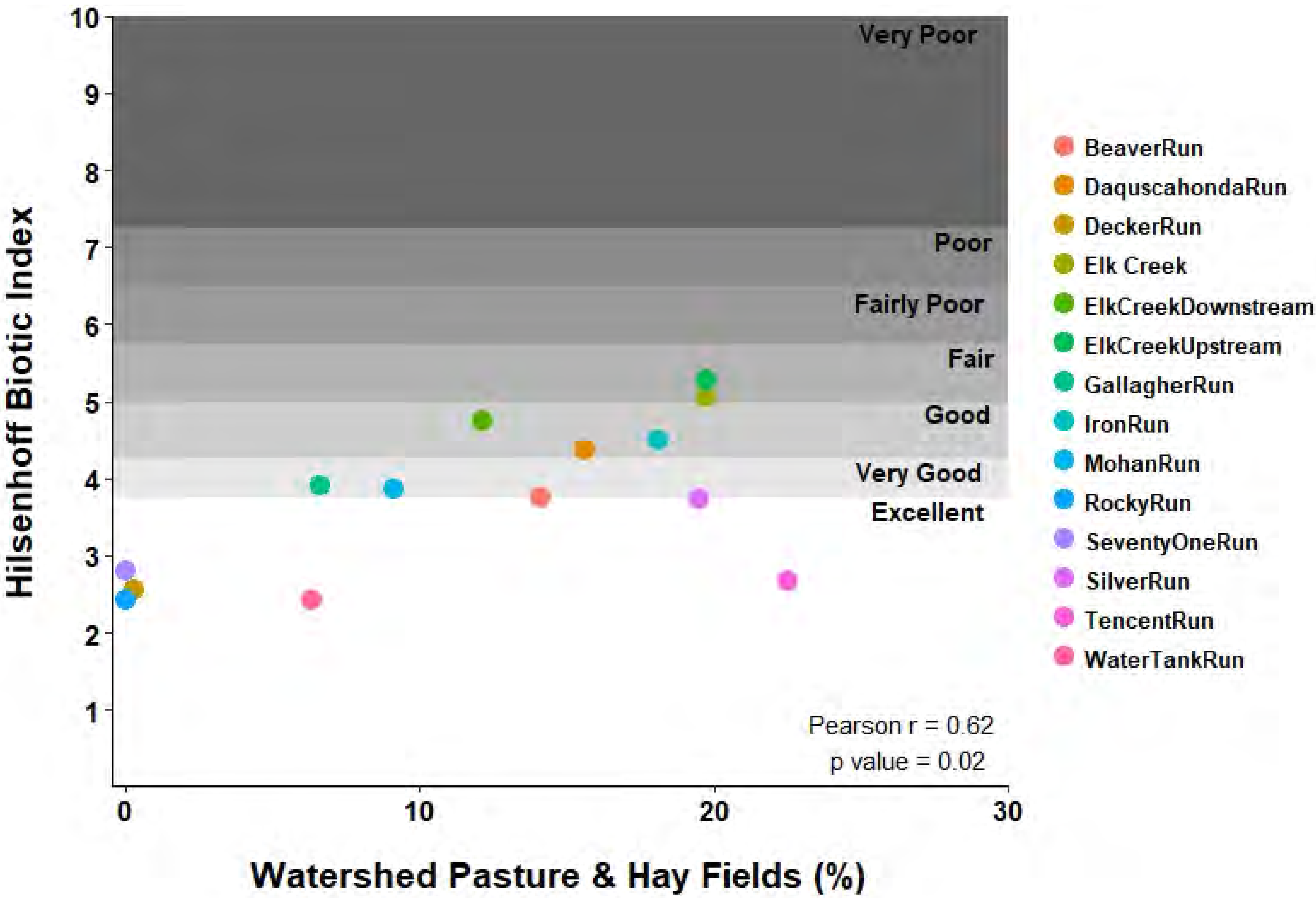


Shannon Weaver Diversity (log10)
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
Watershed Forest (%)
Pearson r = 0.55
p value = 0.04
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun


Very Poor
Poor
Fairly Poor
Fair
Good
Very Good
Excellent
Pearson r = -0.94
p value < 0.01
Hilsenhoff Biotic Index
Watershed Forest (%)
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun



Very Poor
Poor
Fairly Poor
Fair
Good
Very Good
Excellent
Hilsenhoff Biotic Index
Watershed Development (%)
Pearson r = 0.81
p value < 0.01
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun



Very Poor
Poor
Fairly Poor
Fair
Good
Very Good
Excellent
Hilsenhoff Biotic Index
10
9
8
7
6
5
4
3
2
1
0
10
20
30
Watershed Pasture & Hay Fields (%)
Pearson r = 0.62
p value = 0.02
BeaverRun
DaquscahondaRun
DeckerRun
Elk Creek
ElkCreekDownstream
ElkCreekUpstream
GallagherRun
IronRun
MohanRun
RockyRun
SeventyOneRun
SilverRun
TencentRun
WaterTankRun

Table 1. Macroinvertebrate community metrics for upstream, middle, and downstream Elk Creek and its tributaries.

| Macroinvertebrate Community Metrics | | | | | | |
|---|---|---|---|---|---|---|
| **Stream** | **Beaver Run** | **Elk Creek** | **Elk Creek Downstream** | **Elk Creek Upstream** | **Daguscahonda Run** | **Decker Run** |
| Abundance | 338 | 300 | 233 | 7 | 126 | 417 |
| Species Richness | 27 | 20 | 24 | 3 | 25 | 29 |
| EPT Richness | 15 | 5 | 10 | 2 | 13 | 13 |
| Filterer Composition (%) | 44.67 | 30.67 | 36.91 | 42.86 | 17.46 | 14.87 |
| Gatherer Composition (%) | 22.78 | 27 | 33.48 | 0 | 52.38 | 31.41 |
| Predator Composition (%) | 13.91 | 36 | 6.44 | 57.14 | 14.29 | 21.34 |
| Scraper Composition (%) | 6.21 | 6 | 21.89 | 0 | 8.73 | 0.48 |
| Shredder Composition (%) | 12.43 | 0.33 | 0 | 0 | 7.14 | 24.7 |
| Piercer-Herbivore Composition (%) | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Composition (%) | 0 | 0 | 0 | 0 | 0 | 6.95 |
| Shannon-Weaver H (log 10) | 0.95 | 0.94 | 1.06 | 0.42 | 1.02 | 1.14 |
| Hilsenhoff Biotic Index | 3.76 | 5.06 | 4.74 | 5.29 | 4.37 | 2.56 |

| Macroinvertebrate Community Metrics Continued | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Iron Run | Mohan Run | Rocky Run | Silver Run | Seventy One Run | Tencent Run | Water Tank Run |
| Abundance | 449 | 424 | 310 | 1287 | 361 | 380 | 486 |
| Species Richness | 25 | 42 | 26 | 38 | 28 | 37 | 37 |
| EPT Richness | 9 | 28 | 16 | 22 | 20 | 22 | 21 |
| Filterer Composition (%) | 24.5 | 38.92 | 22.58 | 30.07 | 18.01 | 6.32 | 9.47 |
| Gatherer Composition (%) | 39.2 | 33.02 | 17.42 | 41.8 | 36.29 | 34.74 | 38.68 |
| Predator Composition (%) | 25.84 | 10.14 | 11.29 | 6.68 | 9.7 | 12.11 | 8.02 |
| Scraper Composition (%) | 0.22 | 6.13 | 2.58 | 1.86 | 6.65 | 15.53 | 4.73 |
| Shredder Composition (%) | 10.02 | 11.56 | 43.87 | 19.5 | 29.09 | 28.95 | 38.27 |
| Piercer-Herbivore Composition (%) | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Composition (%) | 0 | 0.24 | 2.26 | 0.08 | 0.28 | 2.37 | 0.82 |
| Shannon-Weaver H (log 10) | 1.05 | 1.26 | 1.05 | 0.93 | 1.07 | 1.23 | 1.03 |
| Hilsenhoff Biotic Index | 4.51 | 3.86 | 2.42 | 3.73 | 2.79 | 2.66 | 2.42 |

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# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

| | |
|---|---|
| **STREAM NAME** | **SEGMENT ID** |
| **GIS ID #** ________ | **STREAM CLASS** |
| **LAT** ____________ **LONG** ____________ | **RIVER BASIN** |
| **STORET #** N/A | **AGENCY** |
| **INVESTIGATORS** | |
| **FORM COMPLETED BY** | **DATE** ______________ **TIME** ________ **AM PM** — **REASON FOR SURVEY** |

| | |
|---|---|
| **WEATHER CONDITIONS** | **Now** ☐ clear/sunny ☐ storm (heavy rain) ☐ rain (steady rain) ☐ showers (intermittent) ☐ % cloud cover (circle %) 25% - 50 % - 75% - 100%<br>**Past 24 hours** ☐ clear/sunny ☐ storm (heavy rain) ☐ rain (steady rain) ☐ showers (intermittent) ☐ % cloud cover (circle %) 25% - 50 % - 75% - 100%<br>**Has there been a heavy rain in the last 7 days?** ☐ Yes ☐ No<br>**Air Temperature** ____ °F<br>**Other** ______________________ |
| **FEATURES of NOTE:** | **Describe significant features and/or impacts seen in section. Include GPS points when applicable**<br>☐ Check box if stream is dry and record any significant info about section. |
| **HABITAT IMPROVEMENT OPPORTUNITIES:**<br>**Recommendation(s):** | ☐ Segment has need for improvement project(s)<br>Describe:<br>**Segment Accessibility:**<br>☐ Excellent ☐ Good ☐ Poor ☐ In-Accessible – Describe: ______________________ |
| **STREAM CHARACTERIZATION** | **Stream Subsystem** ☐ Perennial ☐ Intermittent<br>**Stream Type** ☐ Main Stem ☐ Unnamed Tributary ☐ Headwater UNT ☐ Named Tributary ☐ ☐ Other _______<br>**Stream Type** ☐ Coldwater ☐ Warmwater |

| Latitude (North) | Longitude (West) |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

| | |
|---|---|
| **WATERSHED FEATURES** (with in 30 meter buffer) | **Predominant Surrounding Land-Use** (Must = 100%)<br>☐ Forest ___%<br>☐ Field/Pasture ___%<br>☐ Agricultural ___%<br>☐ Open space (i.e., parks/golf courses) ___%<br>☐ Commercial/Industrial ___%<br>☐ Residential ___%<br>☐ Paved Roads ___%<br>☐ Dirt and Gravel Roads ___% (TWP, Gas & Logging)<br>☐ Rail Line ___%<br>☐ Wetland ___%<br>☐ Other __________ ___%<br><br>**Stormwater Inputs** ☐ None<br>☐ Tile Drain ☐ Road Ditch ☐ Urban Stormwater Pipe<br>☐ Field Ditch ☐ Overland Flow<br>**D&GR Sediment Contribution (Runoff):** ☐ None<br>☐ Minimal ☐ Moderate ☐ Heavy<br>**Bank revetments:** ☐ None<br>☐ Rip-rap ☐ Gabion ☐ Concrete ☐ Other ________ |
| **VEGETATION INFORMATION**<br><br>**NOTE:** Bank side determined when facing DOWN Stream | **Riparian Zone Width**    **Riparian Zone Encroachment** ☐ Yes ☐ No<br>Right Bank: ☐ 0 – 15 feet ☐ 16 – 50 feet ☐ 51 – 150 feet ☐ 150 – 300 feet ☐ Greater than 300 feet<br>Left Bank: ☐ 0 – 15 feet ☐ 16 – 50 feet ☐ 51 – 150 feet ☐ 150 – 300 feet ☐ Greater than 300 feet<br>**Indicate dominant vegetation type within riparian zone (~18 meter buffer),and record dominant species present:**<br>☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous ☐ Invasive – Dominant species present: __________<br>**Bank Canopy Vegetation:**<br>Left Bank ☐ 100% (Shaded) ☐ 75% ☐ 50% ☐ 25% ☐ 0% (No Cover)<br>Right Bank ☐ 100% (Shaded) ☐ 75% ☐ 50% ☐ 25% ☐ 0% (No Cover)<br>**Channel Canopy:** ☐ Open ☐ Closed<br>**Presence of Large Woody Debris (LWD):** ☐ Significant ☐ Moderate ☐ Minimal ☐ None<br>**Presence of aquatic vegetation:** ☐ None ☐ Normal ☐ Excessive - Describe: __________ |
| **INSTREAM FEATURES** | **Average Stream Width** ________ ft<br>**Active Streambank Erosion for Segment**<br>☐ None ☐ Minimal ☐ Moderate ☐ Heavy<br>**Surface Velocity:** ☐ Slow ☐ Moderate ☐ Fast<br>**Flow Status:** ☐ Low ☐ Moderate ☐ High<br>**Springs/Seeps:** ☐ Abundant ☐ Minimal ☐ None<br>**Adjacent Wetlands:** ☐ Abundant ☐ Minimal ☐ None<br>**Proportion of Stream Morphology Types**<br>☐ Riffle______% ☐ Run______% ☐ Pool______%<br>**Average Number of Riffles in section** __________<br><br>**Channelization** ☐ No ☐ Yes: Length of Straitening ___ ft<br>**Dam Present (Beaver or Human)** ☐ Yes ☐ No<br>**Constrictions Present :** ☐ None ☐ Culvert ☐ Bridge<br>☐ Old Abutment ☐ Bedrock Outcrop ☐ Other ________<br>**Stream Ford or Animal Crossing Present** ☐ Yes ☐ No<br>**Debris Jam Present** ☐ Yes ☐ No<br>**Connectivity to Flood Plain**<br>(Zero percent equals not connected to flood plain)<br>Right Bank: ☐ 100% ☐ 75% ☐ 50% ☐ 25% ☐ 0%<br>Left Bank: ☐ 100% ☐ 75% ☐ 50% ☐ 25% ☐ 0% |
| **WATER QUALITY**<br><br>(During visual assessment use pH and conductivity meters to take reading.)<br><br>**WQ Instrument(s) Used**<br>__________<br>__________ | pH ______ (Top of section) H2O Temp ______(Top)<br>pH______(Bottom of section) °F or C ______(Bot.)<br>**Specific Conductance (Top)**_______ **(Bottom)**_______<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other_____<br>**Water Odors**<br>☐ Normal/None ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Fishy ☐ Other_________<br><br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Globs ☐ Flecks<br>☐ None ☐ Other__________<br>**Overall Water Quality**<br>☐ Excellent ☐ Good ☐ Fair ☐ Poor<br>**Primary source(s) of water quality impact**<br>☐ Agriculture ☐ Active Pasture ☐ AMD<br>☐ Gas Wells ☐ Development ☐ Sewage<br>☐ Bank Erosion ☐ Sedimentation |

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | |
|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** |
| Bedrock | | |
| Boulder | > 256 mm (10") | |
| Cobble | 64-256 mm (2.5"-10") | |
| Gravel | 2-64 mm (0.1"-2.5") | |
| Sand | 0.06-2mm (gritty) | |
| Silt | 0.004-0.06 mm | |
| Clay | < 0.004 mm (slick) | |

## Additional Notes

**WT Observed? Y or N**    **Coord. of Obs.:**

# HABITAT ASSESSMENT FIELD DATA SHEET – HIGH GRADIENT STREAMS (FRONT)

| | |
|---|---|
| STREAM NAME | GIS ID # ________ |
| SEGMENT ID | STREAM CLASS |
| LAT __________ LONG __________ | RIVER BASIN |
| STORET # N/A | AGENCY |
| INVESTIGATORS | |

| | | |
|---|---|---|
| FORM COMPLETED BY | DATE ______________<br>TIME ________ AM PM | REASON FOR SURVEY<br>Visual Assessment |

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| 1. Epifaunal Substrate & Available Cover | Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient). | 40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| SCORE ___ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| 2. Embeddedness | Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |
| SCORE ___ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| 3. Velocity/ Depth Regimes | All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is >0.5 m). | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/ depth regime (usually slow-deep). |
| SCORE ___ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| 4. Sediment Deposition | Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent. | Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition. |
| SCORE ___ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| 5. Channel Flow Status | Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Water fills >75% of the available channel; or <25% of channel substrate is exposed. | Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Very little water in channel and mostly present as standing pools. |
| SCORE ___ | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

## HABITAT ASSESSMENT FIELD DATA SHEET – HIGH GRADIENT STREAMS (BACK)

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | Optimal | Suboptimal | Marginal | Poor |
| **6. Channel Alteration** | Channelization or dredging absent or minimal; stream with normal pattern. | Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present. | Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted. | Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| **SCORE** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **7. Frequency of Riffles (or bends)** | Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15. | Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. | Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. |
| **SCORE ___** | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **8. Bank Stability (score each bank)**<br><br>**Note: determine left or right side by facing downstream** | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars. |
| **SCORE ___ (LB)** | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **SCORE ___ (RB)** | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **9. Vegetative Protection (score each bank)**<br><br>**Note: determine left or right side by facing downstream** | More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| **SCORE ___ (LB)** | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **SCORE ___ (RB)** | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **10. Riparian Vegetative Zone Width (score each bank riparian zone)** | Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Width of riparian zone 12-18 meters; human activities have impacted zone only minimally. | Width of riparian zone 6-12 meters; human activities have impacted zone a great deal. | Width of riparian zone <6 meters: little or no riparian vegetation due to human activities. |
| **SCORE ___ (LB)** | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **SCORE ___ (RB)** | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

**Total Score ________**

Table 2. Physical characterization of habitat for Elk Creek and its tributaries.

| Habitat Data | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream | Segment | Epifaunal Cover | Embeddedness | Velocity/Depth Regimes | Sediment Deposition | Channel Flow Status | Channel Alteration | Riffle Frequency | Bank Stability | Vegetative Protection | Riparian Vegetated Zone | Overall Score |
| Seventy One | Sev01 | 13 | 13 | 12 | 14 | 9 | 20 | 17 | 18 | 18 | 20 | 14.8 |
| Seventy One | Sev02 | 12 | 15 | 18 | 13 | 16 | 14 | 16 | 18 | 20 | 18 | 15.5 |
| Seventy One | Sev03 | 15 | 11 | 18 | 10 | 15 | 12 | 19 | 16 | 16 | 16 | 14.4 |
| Rocky Run | RR1 | 11 | 9 | 17 | 13 | 18 | 19 | 16 | 19 | 20 | 19 | 15.4 |
| Elk Creek | EC01 | 12 | 15 | 19 | 12 | 19 | 19 | 15 | 14 | 14 | 14 | 14.5 |
| Elk Creek | EC02 | 15 | 13 | 19 | 14 | 18 | 20 | 16 | 18 | 18 | 18 | 16 |
| Elk Creek | EC03 | 12 | 12 | 15 | 13 | 13 | 15 | 18 | 18 | 18 | 12 | 13.9 |
| Elk Creek | EC04 | 15 | 12 | 15 | 13 | 10 | 15 | 18 | 18 | 18 | 18 | 14.5 |
| Elk Creek | EC05 | 10 | 14 | 20 | 15 | 12 | 10 | 16 | 16 | 10 | 10 | 12.5 |
| Elk Creek | EC06 | 12 | 18 | 18 | 15 | 19 | 15 | 18 | 17 | 16 | 14 | 15.3 |
| Elk Creek | EC07 | 12 | 14 | 19 | 15 | 19 | 15 | 19 | 18 | 18 | 18 | 15.7 |
| Elk Creek | EC08 | 12 | 13 | 19 | 14 | 19 | 14 | 19 | 16 | 18 | 18 | 15.4 |
| Elk Creek | EC09 | 13 | 10 | 18 | 15 | 19 | 15 | 19 | 16 | 16 | 16 | 14.9 |
| Elk Creek | EC10 | 11 | 13 | 19 | 15 | 16 | 15 | 16 | 18 | 18 | 14 | 14.6 |
| Elk Creek | EC11 | 10 | 10 | 18 | 15 | 16 | 19 | 16 | 16 | 18 | 18 | 14.6 |
| Elk Creek | EC12 | 15 | 10 | 19 | 15 | 17 | 19 | 19 | 14 | 18 | 18 | 15.5 |
| Elk Creek | EC13 | 14 | 15 | 19 | 13 | 18 | 19 | 16 | 14 | 18 | 18 | 15.5 |
| Elk Creek | EC14 | 15 | 15 | 19 | 15 | 15 | 19 | 19 | 10 | 18 | 16 | 15.3 |
| Elk Creek | EC15 | 16 | 16 | 19 | 15 | 16 | 19 | 19 | 10 | 18 | 18 | 15.7 |
| Elk Creek | EC16 | 14 | 16 | 19 | 15 | 15 | 15 | 19 | 12 | 18 | 18 | 13.9 |
| Elk Creek | EC17 | 11 | 16 | 19 | 15 | 17 | 17 | 18 | 16 | 18 | 18 | 15.5 |
| Elk Creek | EC18 | 11 | 12 | 19 | 15 | 13 | 10 | 19 | 16 | 18 | 10 | 13.5 |
| Elk Creek | EC19 | 8 | 17 | 20 | 12 | 15 | 8 | 18 | 16 | 10 | 10 | 12.7 |
| Water Tank | WT01 | 18 | 18 | 18 | 16 | 19 | 20 | 19 | 20 | 20 | 20 | 17.9 |
| Water Tank | WT02 | 12 | 14 | 16 | 12 | 18 | 19 | 18 | 18 | 18 | 18 | 15.5 |
| Gallagher Run | GR01 | 17 | 12 | 19 | 14 | 19 | 15 | 19 | 18 | 20 | 20 | 16.5 |

| Habitat Data Continued | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream | Segment | Epifaunal Cover | Embeddedness | Velocity/Depth Regimes | Sediment Deposition | Channel Flow Status | Channel Alteration | Riffle Frequency | Bank Stability | Vegetative Protection | Riparian Vegetated Zone | Overall Score |
| Daquscahonda | DG01 | 14 | 15 | 15 | 19 | 18 | 20 | 18 | 18 | 18 | 20 | 16.5 |
| Daquscahonda | DG06 | 15 | 17 | 19 | 19 | 19 | 20 | 18 | 18 | 20 | 20 | 17.5 |
| Daquscahonda | DG07 | 13 | 18 | 19 | 15 | 15 | 19 | 19 | 16 | 20 | 18 | 16.3 |
| Beaver Run | BV01 | 14 | 18 | 19 | 19 | 19 | 19 | 18 | 20 | 20 | 20 | 17.6 |
| Beaver Run | BV02 | 17 | 18 | 13 | 18 | 18 | 19 | 17 | 20 | 20 | 20 | 17.2 |
| Beaver Run | BV03 | 14 | 17 | 19 | 15 | 19 | 20 | 18 | 18 | 20 | 20 | 17.1 |
| Decker Run | DK01 | 19 | 18 | 19 | 15 | 15 | 19 | 19 | 18 | 20 | 20 | 17.4 |
| Tencent Run | TC01 | 19 | 13 | 11 | 14 | 14 | 19 | 19 | 16 | 20 | 19 | 15.7 |
| Tencent Run | TC02 | 17 | 19 | 14 | 15 | 15 | 19 | 18 | 19 | 20 | 20 | 16.8 |
| Laurel Run | LR01 | 11 | 16 | 13 | 14 | 18 | 20 | 19 | 19 | 20 | 20 | 15.9 |
| Laurel Run | LR02 | 14 | 13 | 13 | 15 | 15 | 20 | 19 | 20 | 20 | 20 | 16 |
| Laurel Run | LR03 | 14 | 15 | 16 | 12 | 19 | 16 | 19 | 19 | 20 | 20 | 16.1 |
| Laurel Run | LR04 | 16 | 16 | 10 | 15 | 18 | 19 | 19 | 19 | 20 | 18 | 16.2 |
| Laurel Run | LR06 | 15 | 12 | 13 | 15 | 15 | 19 | 17 | 16 | 20 | 20 | 15.4 |
| Laurel Run | LR07 | 16 | 14 | 7 | 15 | 16 | 19 | 16 | 18 | 20 | 20 | 15.4 |
| Laurel Run | LR08 | 19 | 17 | 17 | 15 | 19 | 19 | 18 | 17 | 20 | 20 | 17.3 |
| Laurel Run | LR09 | 19 | 18 | 18 | 15 | 15 | 20 | 18 | 18 | 18 | 20 | 17.1 |
| Laurel Run | LR10 | 13 | 12 | 14 | 15 | 15 | 20 | 16 | 18 | 20 | 20 | 15.5 |
| Laurel Run | LR11 | 14 | 15 | 19 | 15 | 15 | 16 | 19 | 18 | 20 | 20 | 16.2 |
| Mohan Run | MR01 | 18 | 14 | 20 | 15 | 19 | 19 | 18 | 18 | 20 | 20 | 17.3 |
| Mohan Run | MR02 | 15 | 16 | 15 | 15 | 15 | 17 | 17 | 16 | 20 | 20 | 15.7 |
| Mohan Run | MR03 | 13 | 16 | 14 | 15 | 12 | 19 | 18 | 20 | 20 | 20 | 15.8 |
| Mohan Run | MR04 | 16 | 16 | 16 | 16 | 19 | 19 | 19 | 20 | 20 | 20 | 17.2 |
| Mohan Run | MR05 | 15 | 18 | 19 | 17 | 19 | 19 | 19 | 16 | 20 | 20 | 17.3 |
| Iron Run | IR01 | 12 | 13 | 12 | 13 | 15 | 11 | 18 | 12 | 10 | 10 | 12 |
| Iron Run | IR03 | 19 | 12 | 19 | 15 | 16 | 19 | 19 | 10 | 20 | 20 | 16.2 |
| Silver Run | SR01 | 19 | 13 | 15 | 19 | 16 | 11 | 19 | 16 | 20 | 20 | 16.1 |
| Silver Run | SR02 | 16 | 10 | 20 | 15 | 18 | 19 | 15 | 20 | 20 | 20 | 16.5 |

| Habitat Data Continued | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Segment** | **Epifaunal Cover** | **Embeddedness** | **Velocity/Depth Regimes** | **Sediment Deposition** | **Channel Flow Status** | **Channel Alteration** | **Riffle Frequency** | **Bank Stability** | **Vegetative Protection** | **Riparian Vegetated Zone** | **Overall Score** |
| Silver Run | SR03 | 13 | 13 | 20 | 12 | 15 | 14 | 19 | 10 | 18 | 16 | 14.3 |

Table 3. Model My Watershed results for loading rates within each watershed from the WikiWatershed application.

| WikiWatershed Analysis | | | |
|---|---|---|---|
| **Beaver Run Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 41.5 | 443.7 | 173.8 |
| Row Crop | 33.8 | 509.1 | 111.4 |
| Forest | 1.3 | 232.6 | 14.6 |
| Wetland | 0.1 | 96.4 | 5.3 |
| Open Land | 0.2 | 10.4 | 0.4 |
| Bare Rock | 0.0 | 6.4 | 0.2 |
| LD Developed | 1.0 | 49.2 | 5.3 |
| MD Developed | 0.6 | 25.4 | 2.7 |
| HD Developed | 0.3 | 11.7 | 1.1 |
| Farm Animals | 0.0 | 77.4 | 19.4 |
| Streambank | 42.6 | 50.7 | 22.1 |
| Groundwater | 0.0 | 3146.3 | 127.7 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 49.8 | 0.0 |
| **Dagascahonda Run Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 53.4 | 671.2 | 265.7 |
| Row Crop | 49.2 | 838.6 | 176.0 |
| Forest | 2.4 | 288.9 | 19.4 |
| Wetland | 0.0 | 34.6 | 1.8 |
| Open Land | 1.4 | 54.2 | 3.8 |
| Bare Rock | 0.0 | 24.7 | 0.9 |
| LD Developed | 1.9 | 97.9 | 10.6 |
| MD Developed | 1.1 | 40.6 | 4.2 |
| HD Developed | 0.2 | 5.3 | 0.7 |
| Farm Animals | 0.0 | 148.0 | 36.4 |
| Streambank | 233.2 | 264.6 | 114.7 |
| Groundwater | 0.0 | 5519.8 | 239.7 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 78.1 | 0.0 |
| **Decker Run Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 0.1 | 3.3 | 1.3 |
| Row Crop | 0.0 | 0.0 | 0.0 |
| Forest | 0.7 | 99.0 | 6.6 |
| Wetland | 0.0 | 1.3 | 0.0 |
| Open Land | 0.0 | 0.0 | 0.0 |

| Decker Run Watershed Annual Load Continued | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Bare Rock | 0.0 | 0.0 | 0.0 |
| LD Developed | 0.0 | 0.0 | 0.0 |
| MD Developed | 0.0 | 0.0 | 0.0 |
| HD Developed | 0.0 | 0.0 | 0.0 |
| Farm Animals | 0.0 | 7.3 | 2.4 |
| Streambank | 1.9 | 2.2 | 0.0 |
| Groundwater | 0.0 | 1082.0 | 28.2 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 0.0 | 0.0 |
| **Elk Creek Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 243.1 | 3921.4 | 1526.7 |
| Row Crop | 101.6 | 2325.8 | 436.8 |
| Forest | 15.0 | 2914.1 | 179.3 |
| Wetland | 0.2 | 258.0 | 13.9 |
| Open Land | 4.2 | 275.4 | 13.5 |
| Bare Rock | 0.1 | 93.9 | 3.3 |
| LD Developed | 27.3 | 1429.7 | 152.2 |
| MD Developed | 29.4 | 1222.5 | 125.2 |
| HD Developed | 10.0 | 415.9 | 42.6 |
| Farm Animals | 0.0 | 1220.5 | 306.7 |
| Streambank | 6396.7 | 6978.8 | 3139.9 |
| Groundwater | 0.0 | 46734.5 | 2012.9 |
| Point Source | 0.0 | 14286.2 | 0.0 |
| Septic Systems | 0.0 | 2373.5 | 0.0 |
| **Gallagher Run Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 243.1 | 3921.4 | 1526.7 |
| Row Crop | 101.6 | 2325.8 | 436.8 |
| Forest | 15.0 | 2914.1 | 179.3 |
| Wetland | 0.2 | 258.0 | 13.9 |
| Open Land | 4.2 | 275.4 | 13.5 |
| Bare Rock | 0.1 | 93.9 | 3.3 |
| LD Developed | 27.3 | 1429.7 | 152.2 |
| MD Developed | 29.4 | 1222.5 | 125.2 |
| HD Developed | 10.0 | 415.9 | 42.6 |
| Farm Animals | 0.0 | 1220.5 | 306.7 |
| Streambank | 6396.7 | 6978.8 | 3139.9 |

| Gallagher Run Watershed Annual Load Continued | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Groundwater | 0.0 | 46734.5 | 2012.9 |
| Point Source | 0.0 | 14286.2 | 0.0 |
| Septic Systems | 0.0 | 2373.5 | 0.0 |

| Iron Run Watershed Annual Load | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 53.0 | 577.5 | 233.5 |
| Row Crop | 15.2 | 223.8 | 49.8 |
| Forest | 1.2 | 175.7 | 11.3 |
| Wetland | 0.0 | 20.3 | 1.1 |
| Open Land | 0.1 | 6.4 | 0.4 |
| Bare Rock | 0.0 | 6.0 | 0.2 |
| LD Developed | 6.7 | 355.7 | 37.7 |
| MD Developed | 4.9 | 204.2 | 21.0 |
| HD Developed | 1.6 | 67.3 | 6.8 |
| Farm Animals | 0.0 | 77.4 | 19.4 |
| Streambank | 221.6 | 231.5 | 108.1 |
| Groundwater | 0.0 | 3321.8 | 146.2 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 398.0 | 0.0 |

| Laurel Run Watershed Annual Load | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 69.8 | 742.2 | 299.7 |
| Row Crop | 23.5 | 349.3 | 77.6 |
| Forest | 3.6 | 350.8 | 24.7 |
| Wetland | 0.0 | 18.3 | 1.1 |
| Open Land | 0.5 | 19.6 | 1.3 |
| Bare Rock | 0.0 | 6.4 | 0.2 |
| LD Developed | 1.5 | 77.4 | 8.2 |
| MD Developed | 0.8 | 34.0 | 3.5 |
| HD Developed | 0.4 | 15.4 | 1.5 |
| Farm Animals | 0.0 | 120.0 | 30.4 |
| Streambank | 79.1 | 86.0 | 39.7 |
| Groundwater | 0.0 | 5324.6 | 216.1 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 67.5 | 0.0 |

| Mohan Run Watershed Annual Load | | | |
|---|---|---|---|
| Contributing Source | Sediment (tons) | Total Nitrogen (lbs) | Total Phosphorus (lbs) |
| Hay/Pasture | 24.9 | 170.9 | 72.1 |
| Row Crop | 7.8 | 104.1 | 24.3 |
| Forest | 3.3 | 323.0 | 22.7 |
| Wetland | 0.0 | 22.1 | 1.1 |
| Open Land | 0.0 | 0.0 | 0.0 |
| Bare Rock | 0.0 | 4.4 | 0.2 |
| LD Developed | 0.6 | 29.3 | 3.1 |
| MD Developed | 0.2 | 8.6 | 0.9 |
| HD Developed | 0.0 | 1.3 | 0.2 |
| Farm Animals | 0.0 | 77.4 | 19.4 |
| Streambank | 41.6 | 46.3 | 19.9 |
| Groundwater | 0.0 | 3875.1 | 157.2 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 10.6 | 0.0 |
| **Rocky Run Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 0.0 | 0.0 | 0.0 |
| Row Crop | 0.0 | 0.0 | 0.0 |
| Forest | 0.6 | 145.1 | 8.6 |
| Wetland | 0.0 | 4.2 | 0.2 |
| Open Land | 0.0 | 0.0 | 0.0 |
| Bare Rock | 0.0 | 0.0 | 0.0 |
| LD Developed | 0.0 | 0.0 | 0.0 |
| MD Developed | 0.0 | 0.0 | 0.0 |
| HD Developed | 0.0 | 0.0 | 0.0 |
| Farm Animals | 0.0 | 16.1 | 4.9 |
| Streambank | 3.1 | 4.4 | 2.2 |
| Groundwater | 0.0 | 1609.2 | 42.1 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 0.0 | 0.0 |
| **Seventy One Run Watershed Annual Load** | | | |
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 0.0 | 0.0 | 0.0 |
| Row Crop | 0.0 | 0.0 | 0.0 |
| Forest | 1.8 | 177.5 | 12.6 |
| Wetland | 0.0 | 0.0 | 0.0 |
| Open Land | 0.0 | 0.0 | 0.0 |

| Seventy One Run Watershed Annual Load Continued | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Bare Rock | 0.0 | 0.0 | 0.0 |
| LD Developed | 0.0 | 0.2 | 0.0 |
| MD Developed | 0.0 | 0.0 | 0.0 |
| HD Developed | 0.0 | 0.0 | 0.0 |
| Farm Animals | 0.0 | 34.2 | 8.2 |
| Streambank | 5.1 | 4.4 | 2.2 |
| Groundwater | 0.0 | 1921.0 | 50.3 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 0.0 | 0.0 |

| Silver Run Watershed Annual Load | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 53.6 | 575.3 | 230.9 |
| Row Crop | 8.0 | 107.2 | 24.7 |
| Forest | 1.8 | 247.0 | 16.1 |
| Wetland | 0.0 | 4.4 | 0.2 |
| Open Land | 0.7 | 24.0 | 1.8 |
| Bare Rock | 0.0 | 0.0 | 0.0 |
| LD Developed | 1.6 | 79.8 | 8.6 |
| MD Developed | 0.6 | 26.0 | 2.7 |
| HD Developed | 0.2 | 7.3 | 0.7 |
| Farm Animals | 0.0 | 77.4 | 19.4 |
| Streambank | 89.6 | 94.8 | 44.1 |
| Groundwater | 0.0 | 3365.3 | 146.9 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 53.4 | 0.0 |

| Tencent Run Watershed Annual Load | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 11.3 | 116.2 | 47.2 |
| Row Crop | 12.0 | 158.1 | 37.0 |
| Forest | 0.3 | 25.4 | 2.0 |
| Wetland | 0.0 | 0.0 | 0.0 |
| Open Land | 0.0 | 0.0 | 0.0 |
| Bare Rock | 0.0 | 0.0 | 0.0 |
| LD Developed | 0.2 | 9.5 | 0.9 |
| MD Developed | 0.0 | 1.1 | 0.0 |
| HD Developed | 0.0 | 0.4 | 0.0 |
| Farm Animals | 0.0 | 0.0 | 0.0 |
| Streambank | 7.0 | 6.6 | 4.4 |

| Tencent Run Watershed Annual Load Continued | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Groundwater | 0.0 | 604.6 | 24.5 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 3.5 | 0.0 |

| Water Tank Run Watershed Annual Load | | | |
|---|---|---|---|
| **Contributing Source** | **Sediment (tons)** | **Total Nitrogen (lbs)** | **Total Phosphorus (lbs)** |
| Hay/Pasture | 7.6 | 79.8 | 32.2 |
| Row Crop | 5.1 | 49.6 | 13.5 |
| Forest | 0.7 | 70.1 | 4.9 |
| Wetland | 0.0 | 0.2 | 0.0 |
| Open Land | 9.0 | 104.5 | 19.0 |
| Bare Rock | 0.0 | 0.0 | 0.0 |
| LD Developed | 0.1 | 2.2 | 0.2 |
| MD Developed | 0.0 | 0.0 | 0.0 |
| HD Developed | 0.0 | 0.0 | 0.0 |
| Farm Animals | 0.0 | 7.3 | 2.4 |
| Streambank | 7.1 | 6.6 | 4.4 |
| Groundwater | 0.0 | 1595.5 | 64.8 |
| Point Source | 0.0 | 0.0 | 0.0 |
| Septic Systems | 0.0 | 0.0 | 0.0 |

*Summary of Recommendations*

**<u>AMD Treatment-</u>**

Elk Creek, Iron Run, Decker Run, Daguscahonda Run

**<u>Dam removal-</u>**

Gallagher Run, Mohan Run Silver Run

**<u>ATV crossings management -</u>**

Elk Creek, Beaver Run, Daguscahonda Run, Laurel Run, Silver Run, Tencent Run, Water Tank Run

**<u>Powerline crossing management-</u>**

Elk Creek, Beaver Run, Laurel Run, Mohan Run

**<u>Stormwater Management-</u>**

Elk Creek, Gallagher Run, Iron Run, Silver Run, Decker Run

**<u>Nutrient pollution removal-</u>**

Elk Creek, Beaver Run

**<u>Habitat Structures-</u>**

All

**<u>Riparian zone improvement-</u>**

All

**<u>Woody debris addition</u>**

All

**<u>Streambank improvement-</u>**

All

**<u>Culvert Replacements-</u>**

All

**List of Potential Project Partners**

**City of Saint Marys**

11 Lafayette Street

St. Marys, PA 15857

(814) 781-1718

**Fox Township**

116 Irishtown Road

Kersey, PA 15846

(814) 885-8450

**James Zwald Chapter #314 of Trout Unlimited**

PO Box 505

James City, PA 16734

(814) 837-8762

**LandVest**

210 Main Street

Ridgway, PA 15853

(814) 561-1018

**North Atlantic Aquatic Connectivity Collaborative**

www.streamcontinuity.org

**Ridgway Borough**

108 Main Street

Ridgway, PA 15853

(814) 776-1125

**Ridgway Township**

1537 Montmorenci Road

Ridgway, PA 15853

(814) 773-5625

**Seneca Resources**

51 Zents Boulevard

Brookville, PA 15825

(716) 988-3388

**Pennsylvania Department of Environmental Protection**

230 Chestnut Street

Meadville, PA 16335

(814) 332-6945

**Pennsylvania Department of Transportation**

32 St. Leo Avenue

Ridgway, PA 15853

(814) 772-0038

**Pennsylvania Fish and Boat Commission**

595 east Rolling Ridge Drive

Bellefonte, PA 16823

(814) 359-5250

**Pennsylvania Game Commission**

1566 South Route 44 Highway

Jersey Shore, PA 17740

(570) 389-4744

**Western Pennsylvania Conservancy**

159 Main Street

Ridgway, PA 15853

(814) 776-1114

**List of Potential Funding Sources**

Stackpole-Hall Foundation
www.stackpolhall.org

Colcom Foundation
www.colcomfdn.org

Coldwater Heritage Partnership
www.coldwaterheritage.org

Dominion Energy
https://waterlandlife.org/watershed-mini-grant-program/

Elk County Community Foundation
https://elkcountyfoundation.org/grants/

National Fish and Wildlife Foundation
www.nfwf.org/centralapps/Pages/home.aspx

Pennsylvania Department of Community and Economic Development
https://dced.pa.gov/programs-funding/

PA Department of Conservation and Natural Resources
https://www.dcnr.pa.gov/Communities/Grants/Pages/default.aspx

PA Department of Environmental Protection: Growing Greener
https://www.dep.pa.gov/Citizens/GrantsLoansRebates/Growing-Greener/Pages/default.aspx

Seneca Resources
http://www.natfuel.com/seneca/contact_us.aspx

US Department of Agriculture: Natural Resources Conservation Service
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=stelprdb1048817