



## Beyond reclamation and remediation, next steps in a recovered watershed

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### Extended Abstract

In the 1990s, the Ohio Environmental Protection Agency (OEPA) designated Raccoon Creek in southern Ohio as Limited Resource Water due to coal mining impairment, suggesting that the watershed could not recover. Despite this, since the late 1990's over 20 million US dollars have been invested in the watershed reclamation and treatment. Raccoon Creek Watershed is 684 square miles (1771 km<sup>2</sup>) of land in southern Ohio that flows directly to the Ohio River. The watershed encompasses land from six counties and contains approximately 50,000 ac (20,235 ha) of abandoned underground and surface mines (Bowman et al. 2019). Treatment and reclamation projects have included land reclamation of surface pits and coal processing areas, numerous steel slag leach beds, a lime doser, wetland systems, and a vertical flow reactor (Bowman et al. 2019). Mining impairment is concentrated in the headwaters in the north and the main tributary, Little Raccoon Creek in the west. Fig. 1 shows the location of mining impairment and treatment and reclamation projects completed to date. Fig. 2 shows the primarily forested land cover of the rural watershed.

For the past 25 years, watershed partners have focussed on treatment and reclamation of the sites that were shown to lead to reduced biological metrics, primarily fish and aquatic macroinvertebrates. With the clustering of mining impairment in two main areas of the watershed, the headwaters in the north and Little Raccoon Creek in the west, treatment and reclamation in these areas has many kilometers of stream to accrue the results. The primarily forested nature of the stream supports high quality habitat. In this way, the water quality gains achieved upstream allow for biological recovery downstream.

Ohio University has partnered with the Ohio Department of Natural Resources (ODNR) and OEPA to monitor the watershed for water quality, aquatic biology, and habitat for over two decades (e.g. Bowman et al. 2019 and data available at [www.watersheddate.com](http://www.watersheddate.com)), but a comprehensive evaluation through OEPA's Total Maximum Daily Load (TMDL) was not completed between the mid 1990's and the OEPA study in 2016 (OEPA 2020). TMDL studies include extensive chemical monitoring, fish and aquatic macroinvertebrate assessment, and habitat assessment. These data were then analyzed to determine remaining impairments, set watershed goals, and suggest an update to the aquatic use designation (i.e. Limited Resource Water) after extensive treatment.

The TMDL study (OEPA 2020) showed an improvement in all metrics and led to re-designation of the stream based on these updated data. The mainstem from the headwaters of Raccoon Creek at river mile 110 to river mile 40 in the town of Vinton have been re-designated as Warm Water Habitat, indicative of conditions in the 25%–75% of all sites in Ohio. The stream from river mile 40 to the backwaters of the Ohio River have been re-designated as Exceptional Warm Water Habitat, which is assigned to sites in the top 25% of all sites in Ohio (OEPA 2020). The transition between Warm Water Habitat and Exceptional Warm Water habitat is a low head dam that

restricts fish passage. It is unheard of for streams to move from Limited Resource Water to Exceptional Warm Water Habitat.

While the watershed-wide recovery is certainly a success story, it is the results of over \$20 million of investment over multiple decades. Notable projects and areas of treatment and reclamation focus include: a lime doser in Hewett Fork that avoids fish kills on the mainstem of Raccoon Creek and has allowed biological recovery in the lowest stream reaches; extensive land reclamation in the West Branch of Raccoon Creek and reclamation and steel slag leach bed treatment in East Branch of Raccoon Creek, reducing the influence of the tributaries that give rise to the mainstem nearly 110 mi (177 km) from the Ohio River; and land reclamation, steel slag leach beds, and vertical flow reactors in Little Raccoon Creek that have allowed the largest tributary to support a diverse ecosystem of fish species when, in the 1980's, it supported fewer than 10 species.

The redesignation of the stream as Warm Water and Exceptional Warm Water Habitat is a true reflection of watershed-scale approaches to treatment and reclamation and prioritization of projects. This has opened new opportunities for the watershed. The watershed improvement allows for growth in recreational opportunities. Watershed leaders are now pursuing Scenic River designation; there is currently no river in southeast Ohio that has earned this designation. The state Scenic River criteria include three levels, Wild, Scenic, and Recreational. Each has its own criteria for designation including in-tact riparian, limited roads within a buffer around the creek, limited bridge crossings, free flowing nature, limited commercial space near the creek, and good water quality (ORC 2016). Geographic analysis was used to assess the mainstem of Raccoon Creek and Little Raccoon Creek for each criterion. Fig. 3 show examples of this analysis for vegetated riparian within a 120 ft (36.5 m) buffer of the stream. The analysis suggests that much of the mainstem and Little Raccoon Creek would meet criteria for Wilder, Scenic, or Recreational River status set by the State of Ohio. Ohio University and Raccoon Creek Partnership are now pursuing designation with the state by both reporting on this analysis and garnering support from community members and leaders.

This extended effort in a large watershed shows the value of targeting treatment sites with an eye towards cumulative results downstream rather than discharge requirements for a single site and the role of sustained effort and commitment from agencies, community, and academic partners. There is now a private canoe livery, water trail maps showing access, features, and hazards, and anglers enjoying the watershed.

**Keywords:** Biological recovery, bioassessment, Scenic River, recreation

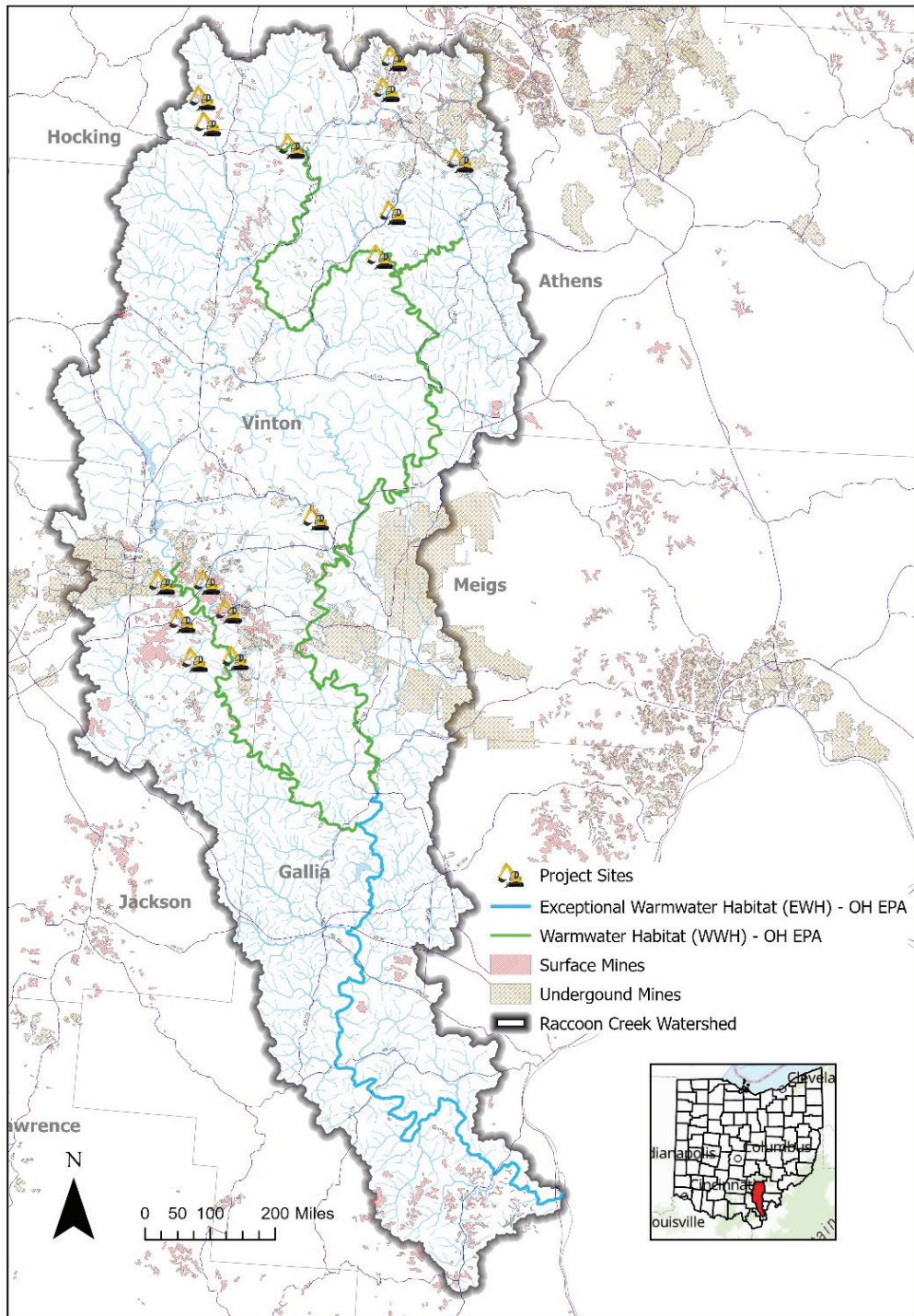
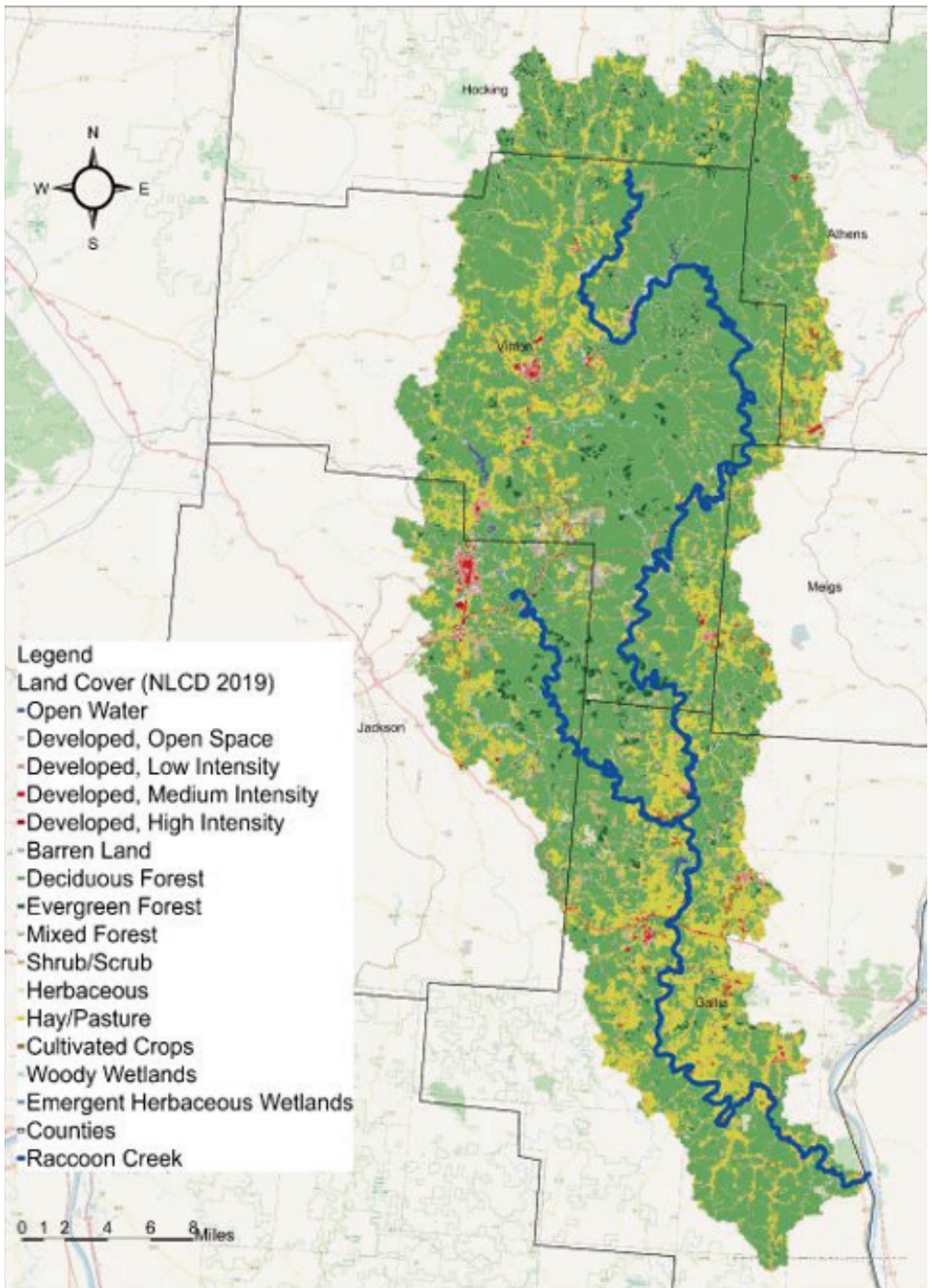


Figure 1 Location of abandoned surface and underground mines and treatment and reclamation project sites. The mainstem, Little Raccoon Creek in the west, and Hewett Fork in the northeast are symbolized by aquatic use designation





*Figure 2 Land cover in Raccoon Creek Watershed. The mainstem of the creek flows from north to south with the largest tributary, Little Raccoon Creek, draining the western portion of the watershed. The land cover is overwhelmingly forested with limited agriculture and developed area*

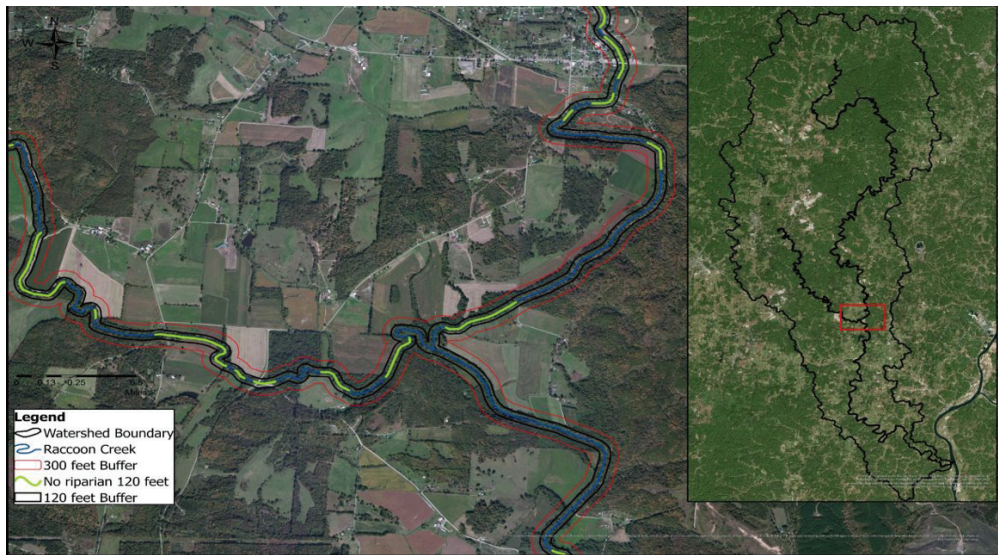


Figure 3 Riparian area within a buffer along each stream bank was characterized as intact or lacking riparian

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