The effects of a plug of alkaline water in an acid stressed watershed

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Extended Abstract

Alkaline addition is a common strategy to treat acid mine drainage, adding sufficient alkaline material to buffer acid and reduce metal solubility. Alkaline addition aims to treat acid stressed environments. Previous work has suggested that it takes multiple years for a stream system to recover from short-term acidification (Kruse *et al*. 2012). This study aims to quantify the chemical and biological impacts of a pulse of alkaline water in a previously acid stressed stream.

Hewett Fork is a subwatershed of the heavily coal mined Raccoon Creek watershed in Southeastern Ohio. Three major acid sources, the Rice-Hocking Mine at Carbondale, Carbondale Creek, and Trace Run (Fig. 1) are treated by a lime doser located at the discharge from the Rice-Hocking Mine at the site labelled Carbondale Doser in Fig. 1, 11 mi (17.7 km) from the mouth of Hewett Fork. During typical operation, enough alkalinity is added by the Carbondale Doser to buffer the acidity from all three acid sources, allowing biological recovery further downstream. Typically, the alkalinity added by the doser is consumed by Waterloo and additional alkalinity enters the watershed from alkaline tributaries (Kruse *et al*. 2013).

After several months of inconsistent operation of the lime doser in Carbondale, Ohio, during the Spring of 2014 due to bridging of fine lime in the doser, the doser was manually unloaded to allow for delivery of coarser material. Approximately ten tons of lime were emptied into the stream channel over an eight-hour period at the site labelled Carbondale Doser in Fig. 1. Water quality was monitored 1.2 mi (2 km) downstream of the doser at site Route 56 (conductivity, temperature, water depth), 2.6 mi (4.3 km) downstream of the doser at site Waterloo (pH, conductivity, total dissolved solids, temperature, ORP), and 6.3 mi (10.1 km) downstream of the doser at site King Tunnel (pH, conductivity, total dissolved solids, temperature, ORP). Locations are shown in Figure 1. Water quality logging began two weeks before the doser was unloaded and continued for six weeks after. Macroinvertebrates were sampled six weeks after the doser was unloaded and used to calculate the multimetric index, MAIS (Macroinvertebrate Aggregated Index for Streams, Johnson 2007, Smith and Voshell 1997), used in Ohio to assess acid mine drainage stress.

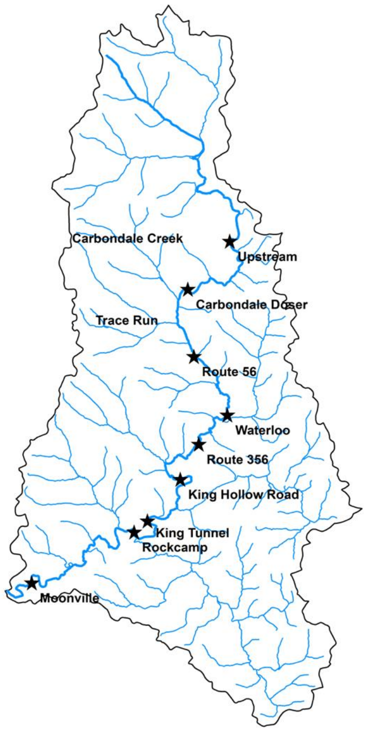

***Figure 1** Map of Hewett Fork Subwatershed located in Raccoon Creek Watershed in Southeastern Ohio. Long term sample locations are notated with black stars. The current study assesses the impact of an alkaline release from the Carbondale Doser site at Route 56, Waterloo, and King Tunnel sites.*

While in-stream chemistry in the day that followed the doser unloading did exceed ideal ranges for aquatic life both 1.2 mi (2 km) and 2.6 mi (4.3 km) downstream (pH > 11, conductivity > 3000 µS/cm), as shown in Fig. 2 and 3. The water quality impacts were much more moderate 6.3 mi (10.1 km) downstream, as shown in Fig. 4. The large alkaline pulse had a short extent, but had large water quality impacts in that zone; however, the section of stream that had the largest water quality changes was also the section of stream that had the poorest biological recovery (Fig. 5).

Before the alkaline pulse of water in this watershed, the biological community had improved from 6.3 mi (10.1 km) downstream of the doser to the mouth of the stream. The 2014 macroinvertebrate data shown in Fig. 5 suggests that the hyper-alkaline water did not significantly impact the biological community; there was no significant change from the previous year. One hypothesis of the mechanism for limited biological recovery is episodic pulses of poor water quality. This case suggests that this may be the case in a limited section of the stream and should be studied further.

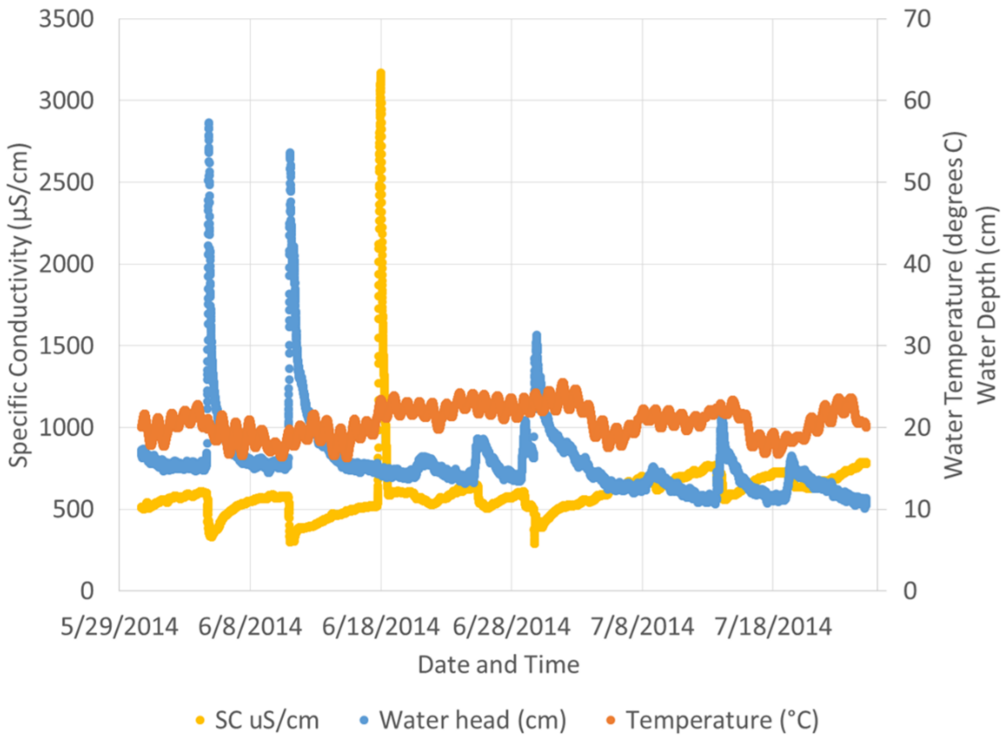

Figure 2 *Water quality at Route 56 shows the large increase in specific conductivity (SC) after the doser is unloaded on June 18, 2014. Other variations in SC at this site have a relationship with depth of water.*

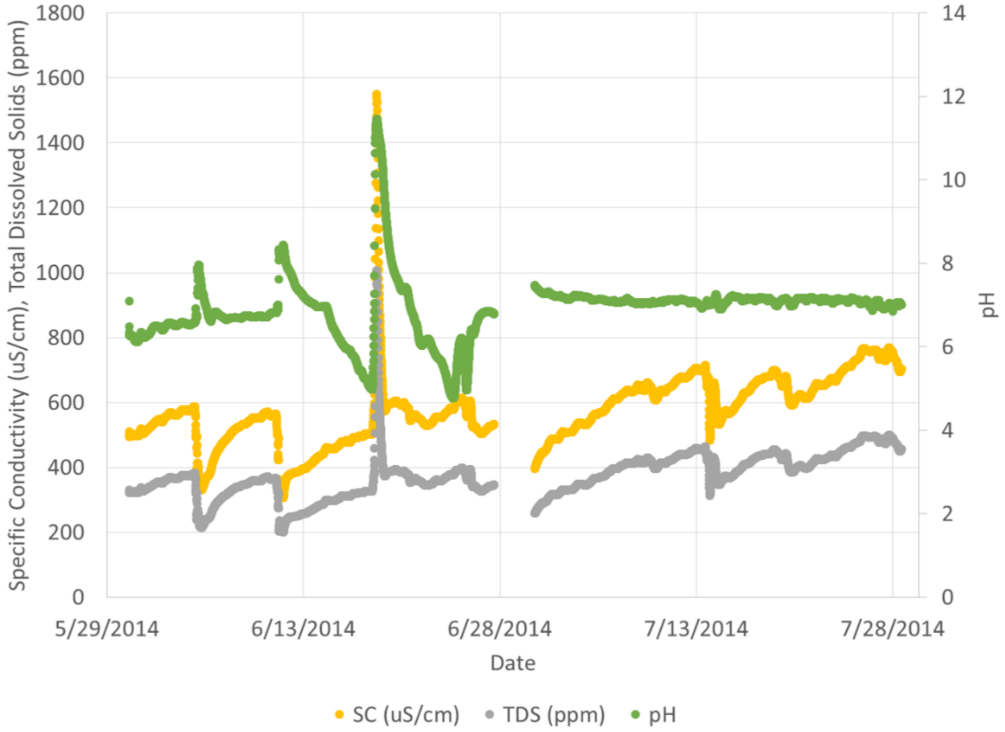

Figure 3 *Water quality at Waterloo shows a large increase in both specific conductivity (SC) and pH following unloading of the doser. The pH peaked at over 11 and SC peaked at over 1500 uS/cm.*

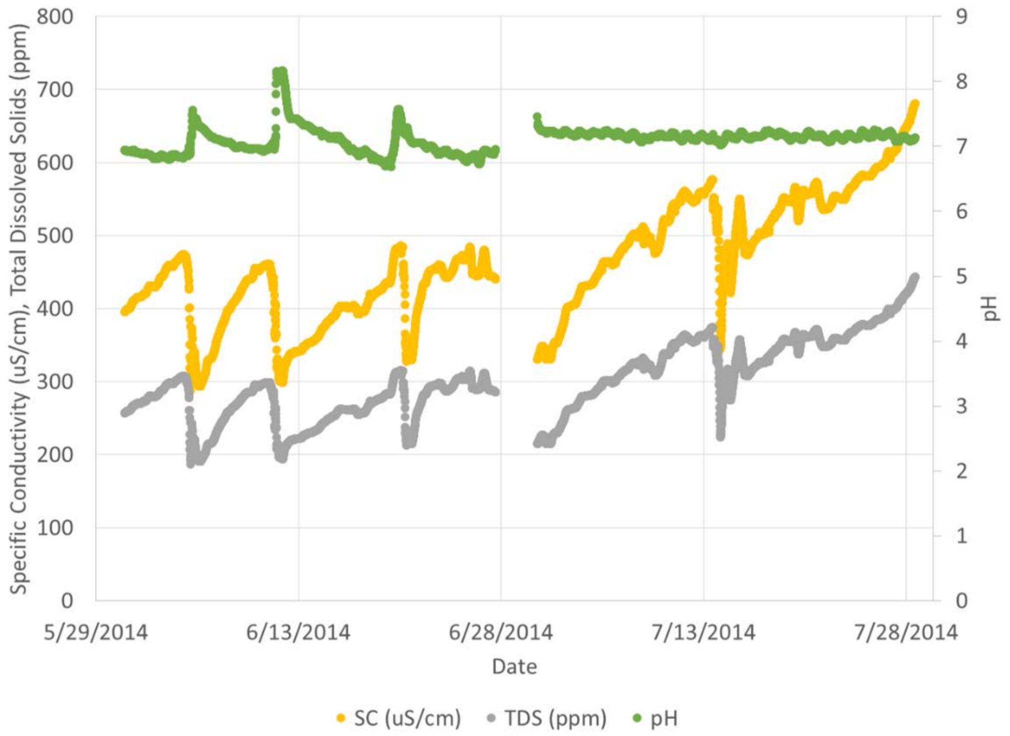

Figure 4 *Water quality at King Tunnel revealed that natural variation in pH was greater than the variation seen on June 18, 2014 due to the alkaline pulse. The pH peaked at less than 8.*

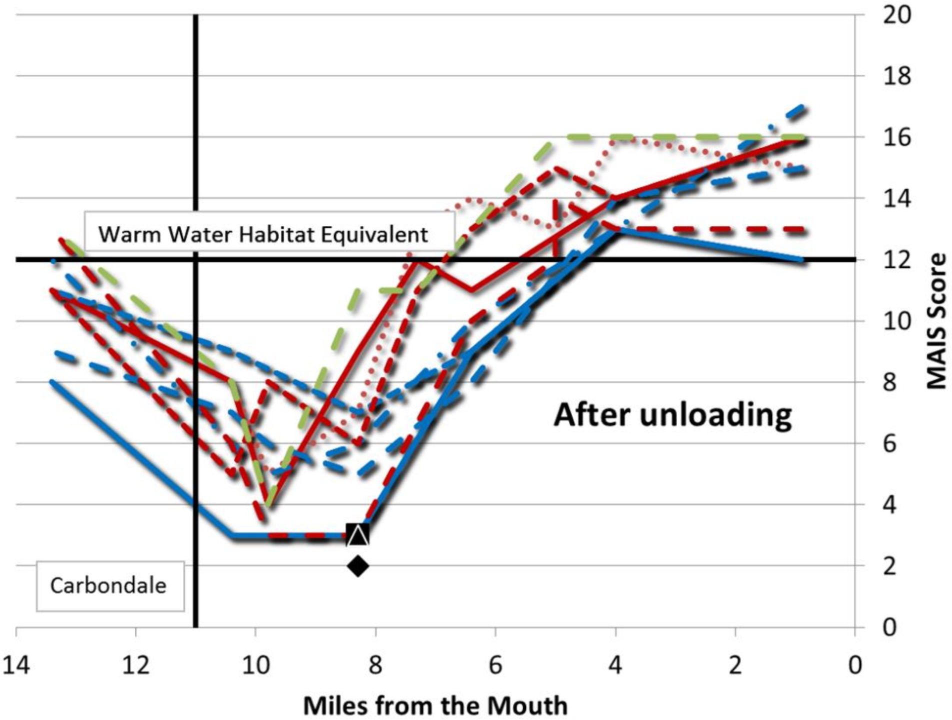

Figure 5 *MAIS scores in Hewett Fork since 2001. Black symbols represent pre-treatment scores, blue lines represent years 2004 – 2009, red lines represent years 2010 – 2013 showing the decrease in scores caused by 2 weeks of non-treatment at Carbondale as detailed in Kruse et al. 2012, the green line represents 2014 data. The lowest values are pre-treatment, scores from the 2007 drought year, and from 2010 after 2 weeks of non-treatment.*

While previous work (Kruse *et al.* 2012) suggests that short term acidification (~2 weeks) can impact the biological community for several years, a short term alkaline episode (~1 day) does not

significantly impact the biological community. This suggests that there may be a threshhold of duration of impact that macroinvertebrates can withstand or that alkaline tolerance may be greater than acid tolerance.

Key words: Mine water, hyper-alkaline, lime doser

References

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