WEST VIRGINIA WATER RESEARCH INSTITUTE

THREE RIVERS QUEST

Targeted Study

Upper Ohio River Watershed: Temperature and Specific Conductance

Project Description :

Nineteen of the 20 hottest years on record have occurred since 2001 (NASA, 2020) with 2020 nearly tied for the hottest in that 140-year record (NOAA, 2020). 2020 was also dry in the Upper Ohio area, with Wheeling reporting the 4th driest year on record, 7" below average (USNews, 2020). These temporal changes can have significant impacts on local streams and water bodies. Assistant Professor James Wood and undergraduate research student Emily Huff in the Ecology and Ecosystems Study (EES) lab at West Liberty University set out to answer the question of, "how did water chemistry compare between 2020 and 2019?" They chose to focus on two water chemistry parameters, water temperature and specific conductance (SpC). This study aimed to answer the question: Was water temperature and specific conductance of the stream water significantly higher in 2020 compared to 2019 at our monitored sites?

Background:

These two variables, temperature and SpC, are important to monitor because they provide insights into the health of the waterbody being sampled. Specific conductance is a measure of the dissolved salts and metals in the water; the higher the conductivity the more salts and metals there are in the water. High specific conductance can indicate high pollution loads from urbanization, road salts, sewage, or mining activity (EPA, 2016). High SpC can harm aquatic life by interfering with osmoregulation and gill function.

Similarly, high water temperatures can also harm aquatic life, specifically by decreasing the availability of oxygen in the water as well as affecting the growth and productivity of stream organisms (EPA, 2016). In general, high water temperature is harmful for many fish and aquatic insects. The summer months are often the most stressful for aquatic organisms due to the increase in water temperature, frequent low flow conditions with few places in the stream to escape the summer heat.

Methods:

Twenty-four sites were chosen for analysis that had been monitored weekly by EES lab in the Upper Ohio River watershed near Wheeling, WV. (figure 1.). Some of the sites are on relatively healthy streams like Wheeling and Buffalo Creeks, while other sites are heavily impacted by acid mine drainage (AMD). Water temperature and SpC was measured with a calibrated YSI QuatroPro field meter as part of our normal monitoring that began in 2018. The researchers defined "summer" as ranging from June 1st to September 30th. Wilcoxon Signed Range tests (similar to a T-tests) was used to determine if water temperature and SpC were significantly different between summer 2019 and summer 2020.

Figure 1. The twenty-four sampled sites in the Upper Ohio River watershed near Wheeling, WV. Site markers are as follows: Blue – Wheeling Creek and tributaries; dark orange – Short Creek and tributaries; green – Buffalo Creek and tributaries; red – Ohio River; orange-direct tributaries to the Ohio River; stars indicate AMD impacted sites.

Findings:

The researchers found that of the total 24 monitored sites, mean summer water temperature in 2020 was higher in 47% of the sites, but only one of the sites was significantly…

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Findings:

warmer in 2020 (Figure 2). However, mean summer SpC in 2020 was higher in all 24 sites and significantly higher ($p < 0.05$) in 58% of sites. When averaged across the 21 non-AMD impacted sites, mean SpC in summer 2020 increased by 88 µS cm^{-1} compared to 2019, while water temperature increased by only 0.2ºC.

Of the three AMD impacted sites, none had higher mean summer temperature in 2020. However, SpC at two of the three AMD impacted sites was significantly higher in 2020, while the third site had marginally higher SpC ($P = 0.08$). On average SpC increased by 773 µS cm^{-1} at the AMD sites (range 165-1502 µS cm-1) but mean water temperature decreased by 1ºC in 2020 (range -0.3 – -1.4ºC). The changes observed at AMD sites are possibly the result of a decrease in precipitation infiltrating into mines, resulting in reduced dilution of the concentrated effluent and an increase in the proportion of the mine's discharge coming from cool groundwater rich in dissolved metals thus reducing the water temperature and increasing the SpC.

Overall, these findings indicate that the hot and dry 2020 summer had a larger effect on SpC than it did on water temperature in these streams.

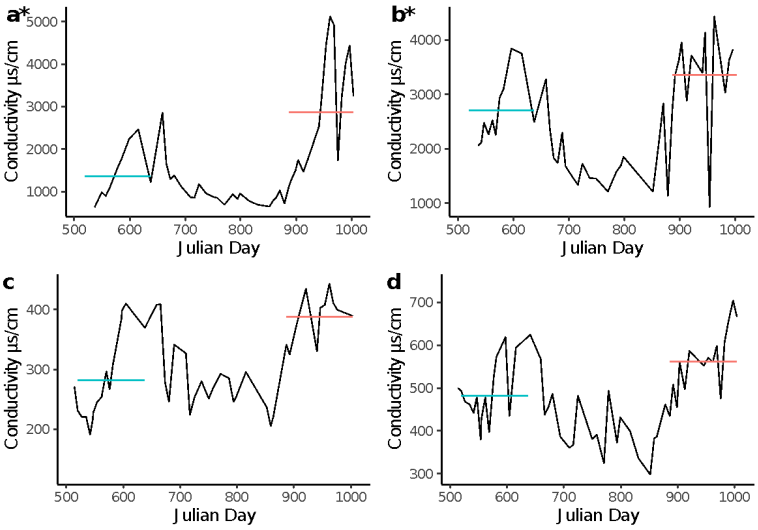

Figure 2. Specific conductance (SpC) of four of the 24 water quality monitoring sites between summer 2019 and 2020; a direct tributary to the Ohio River* (a), a tributary to Wheeling Creek*(b), Ohio River (c), and Wheeling Creek (d). Blue bars represent the summer period and the mean SpC for 2019 while red bars represent the summer period and mean SpC for 2020. Summer was defined as from June 1st – September 30th. An "*" indicates sites impacted by acid mine drainage. Julian Day 500 is May 15th, 2019 of the water quality monitoring data set. Conductivity was significantly different ($P<0.05$) in 2019 than summer 2020 in all sites shown.

Discussion :

Hot dry summers can typically lead to lower flows in streams which can in turn increase water temperature and conductivity of stream water and negatively impact stream organisms. Overall, the data gathered from this study indicates that the hot dry summer of 2020 impacted a majority of the sites, by showing increases in SpC and to a lesser extent higher water temperatures. Streams impacted by AMD may be acutely susceptible to prolonged dry conditions resulting in increased concentrations of metals exported into downstream waterways.

Protecting waterways from the impacts of climate change is paramount but will be challenging. One way to help mitigate the impacts of climate change on streams is to increase tree cover along streams banks, commonly called riparian buffers zones. Riparian buffer zones can help filter out metals and other pollutions before they are washed to streams. Tree cover can also help regulate water temperature by shading the stream in summer and providing habitat for aquatic organisms (University of Massachusetts Amherst, 2017).

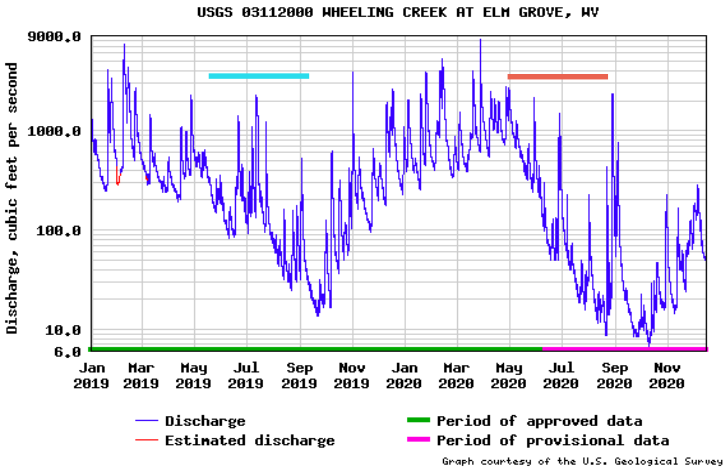

Figure 3. Hydrograph of Wheeling Creek near Wheeling, West Virginia from January 2019 to December 2020. Light blue bars indicate summer (2019) and red bars indicate summer 2020. Note the lower discharge in the summer and early fall of 2020 compared to 2019.

References :

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