Investigating the effects of acid mine drainage on macroinvertebrate diversity, community composition and water quality.

By Louise Britton
**Aims**
- Investigate the potential differences in water quality between eight sites upstream and downstream from a source of acid mine drainage (AMD).

**Objectives**
- Analyze taxonomic richness, abundance and community composition
- Water quality analysis tools

**Hypothesis**
- Higher concentrations of sulphate and iron downstream from AMD
- Dissolved oxygen will decrease, temperature will increase, conductivity will increase, pH will increase
- Taxonomic richness and abundance of macroinvertebrates will decrease downstream from AMD.
Why are macroinvertebrates good indicators of water quality?

- Macroinvertebrates spend most of their life cycles in freshwater environments, (Belle et al., 2020).
- Some macroinvertebrates are more sensitive or tolerant to the water quality they live in, (Mahler & Barber, 2017).
- Sensitive species include EPT taxa.
- Studies have proven a correlation between acidity of the water and community composition of macroinvertebrates, (Tripole et al., 2008)
Why is iron and sulphate a good indicator of water quality?

- AMD increases the concentrations of sulphate and iron in freshwater systems, (Buzatu et al., 2016, Lefebvre et al., 2012)
- High sulphate concentrations can cause internal eutrophication in plants and biodegradation of soils, (Cirkel et al., 2014, Clemente et al., 2003)
- High levels of iron have been proven to increase mortality rate in macroinvertebrates and fish by smothering riverbeds (Rasmussen & Lindegaard, 1988)
Why is this study important?

- Problems with acid mine drainage
  - Many macroinvertebrate species are intolerant to changes in pH, (Sola et al., 2004)
  - Affects the chemistry of the water
  - Shown to increase mortality in fish species, (Todd et al., 2007)

- Scale of acid mine drainage
  - According to the EU water Framework directive only 14% of rivers in England meet the good ecological status (Bevan, 2020)

Figure 2 - map of UK acid mine drainage discharge, (Environment agency, 2008)
Introduction

- Catchment of 16.55km²
- 6.9km long
- Located in west Yorkshire, Jackson Bridge
- Tributary of the River Holme
- Catchment is dominated by broadleaf woodland (19%0 and housing (81%)
- Average precipitation of 1028.4 mm per year, (Met office, 2017)

Figure 3 - Map showing the location of the four upstream sites that were sampled upstream of the point source of AMD, (Digimap, 2020).
Introduction cont.

- 3 upstream sites
- Average velocity of water on day of collection was 0.16m/s

Figure 4 - Map showing the point source of AMD in Jackson Bridge and the location of three of the downstream sites that were sampled, (Digimap, 2020)
Site 8 was situated much further downstream to highlight how the concentration of acid mine drainage had been diluted after joining the River Holme. This helps to highlight the recovery of the stream.

Figure 5a, 5b - The location of Site 8 that was sampled. Figure 5a shows where Site 8 is located in Brockholes. Figure 5b shows Site 8 in relation to the other three downstream sites which are much closer to the point source of AMD and the distance between the, (Digimap, 2020).

- Site 8 was situated much further downstream to highlight how the concentration of acid mine drainage had been diluted after joining the River Holme.
- This helps to highlight the recovery of the stream.
Methodology

- Macroinvertebrate collecting
- Macroinvertebrate analysis and identification
- Water sampling
- Water chemical analysis

Figure 6 - Image of kick sampling
Macroinvertebrate sampling

- Macroinvertebrate sampling
- Separating
- Macroinvertebrate identification

Figure 7a, 7b - 7a kick sampling technique image, 7b macroinvertebrates identification in lab image
Water quality sampling

- Water sampling
- Reading multi-parameter probe
- Water chemical analysis in laboratory

Figure 8 - (YSII, 2020)

Figure 9 - Hach Lange machine image
Statistical analysis

- Calculated the abundance and taxonomic richness
- Used R program to calculate significance.
- Significance calculated for all variables
- Analysis of similarities
- NMDS
- Site 8 was not used in any statistical analysis
Results

Water quality results

Macroinvertebrate results
Water quality results

- Sulphate = no significant difference (p=2.87)
- Iron = significant difference (p=0.0284)

Figure 12 - Concentrations of sulphate 680 present in 8 water samples upstream and downstream of a point source of AMD at New Mill Dike.

Figure 13 - Concentrations of iron FerroVer present in 8 water samples upstream and downstream of a source of AMD at New Mill Dike.
Water quality results

- pH = not significantly different (p=0.5537)
- Dissolved oxygen = not significantly different (p=0.9521)
- Conductivity = significantly different (p=0.0001)
- Temperature = significantly different (p=0.0002)

<table>
<thead>
<tr>
<th>Variable mean</th>
<th>Upstream</th>
<th>Downstream</th>
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<tbody>
<tr>
<td>Pressure</td>
<td>734.1</td>
<td>745.63</td>
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<tr>
<td>pH</td>
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<td>Conductivity</td>
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<tr>
<td>Temperature</td>
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<tr>
<td>Dissolved oxygen</td>
<td>92.15</td>
<td>92.3</td>
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</table>

Table 1 - mean water quality variables upstream and downstream,
Macroinvertebrate results

- 22 macroinvertebrate families, 253 individuals identified.
- Abundance = significantly different (p=0.05714)
- Taxonomic richness = not significantly different (p=4.136)

Figure 14 - Abundance of macroinvertebrates upstream and downstream of the AMD source. From Site 1 to Site 8

Figure 15 - Species richness of macroinvertebrates upstream and downstream of AMD site
Similarities in community composition

- Significance of 0.028671

Figure 16 - Non-metric multidimensional scaling plots graph which highlights dissimilarities between upstream and downstream community composition of macroinvertebrates communities.

Figure 17a, 17b - Pie chart showing the percentage of different macroinvertebrate families in three downstream (17a) and upstream (17b) sites at New Mill Dike.
Discussion - why did we see these results?

Macroinvertebrate results

- Abundance results support hypothesis
- Taxonomic richness is not significant between upstream and downstream sites but the number of individuals in each species is. EPT taxa present in both samples but there are higher concentrations of EPT taxa upstream.

Water quality results

- Conductivity support hypothesis
- pH is not different - sites not collected immediately downstream (dilution effect)
- Temperature support hypothesis
- Dissolved oxygen and sulphate concentrations didn’t change (dilution effect)
- Iron concentrations support hypothesis
Limitations/ future research

Future research

➢ Greater number of sites sampled and analyzed
➢ Identification of species could be more in depth (genus levels)
➢ Greater number of researchers would allow more samples to be taken
➢ Future work could be focused on the dilution effect and recovery of new mill dike after the tributary with the River Holme
➢ Data could be collected at different times of the year to analyze seasonal variability in concentrations of AMD

Limitations

➢ Access to the stream
➢ COVID 19
Questions?
References


