Iron & Manganese Oxidation Cycles in a Local Drinking Reservoir
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1. INTRODUCTION
- Iron (Fe) and manganese (Mn) in drinking water can affect water quality by causing taste and odor problems.
- The EPA lists both Fe and Mn as secondary contaminants, which can present a risk to human health.
- During the summer months, thermal stratification of lakes and reservoirs can result in low dissolved oxygen in the hypolimnion (bottom waters).
- Low dissolved oxygen leads to the reduction of insoluble Fe and Mn in sediment, releasing soluble Fe and Mn into the water column.
- Hypolimnic oxygenation systems are being increasingly used to prevent the reduction and release of soluble Fe and Mn into the water.

2. SITE DESCRIPTION

Falling Creek Reservoir (FCR) (Figure 1)
- Primary study site
- Owned and operated by the Western Virginia Water Authority (WVWA)
- Surface Area: 1.19 x 10^4 km²
- Max Depth: 9.3 m
- Thermal stratification occurs annually from May to October
- Historical issues with low dissolved oxygen (DO) during thermal stratification
- Side stream supersaturation (SSS) oxygenation system installed in 2013 (Figure 2).
- The SSS was first operational in May 2013, but was only run intermittently during stratification. Since 2016, the SSS has been fully operational during the thermal stratification period of May to October.

Beaverdam Reservoir (BVR) (Figure 3)
- Reference reservoir
- Owned and operated by the Western Virginia Water Authority (WVWA)
- Surface Area: 3.9 x 10^4 km²
- Max Depth: 13.5 m
- Thermal stratification occurs annually from May to October
- Historical issues with low dissolved oxygen (DO) during thermal stratification
- No oxygenation system
- Acts as primary inflow to FCR

3. METHODS
- Samples were collected weekly from each reservoir for 6 weeks (Mid June – Late July) to measure total and soluble Fe and Mn concentrations.
- Samples were collected along a depth profile (FCR: 0.1, 1.6, 3.8, 5.0, 8.0 m below the surface; BVR: 0.1, 3.0, 6.0, 9.0, 11.0 m below the surface).
- Soluble metal samples were filtered using a 0.45 μm nylon filter.
- Samples were directly poured from a 4L Van Dorn water sampler into 15 mL centrifuge tubes.
- Samples were preserved using trace metal grade nitric acid.
- Samples were analyzed for Fe and Mn using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

4. RESULTS: IRON
- Fe concentrations for FCR (Figure 5) and BVR (Figure 6) from 2014-2017.
- Oxygenation intermittent in 2014, continuous in 2015 (with exception of one week in June) and in 2016 and 2017.

5. CONCLUSIONS
- Continuous oxygenation lowers Fe and Mn concentrations in FCR.
- Total and soluble Mn concentrations at FCR are similar each year because Mn oxidized more slowly than Fe.
- Lack of oxygenation at BVR results in biological Fe and Mn reduction in reservoir sediments, which are released as soluble metals in the water, resulting in elevated concentrations in the hypolimnion.

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