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**Supplemental Information**

Table S1: Levene tests and ANOVA results describing differences in sediment characteristics between BVR in 2019, BVR in 2021, FCR in 2019 (all data pooled), and FCR in 2021.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Levene statistic | Levene p-value | Test used | F | df | ANOVA p-value |
| Fe-OC (% of sediment OC) | 1.21 | 0.32 | ANOVA | 17.2 | 3, 46 | **< 0.001** |
| OC (% of sediment mass) | 3.69 | **0.017** | Welch’s ANOVA | 14.6 | 3, 28 | **< 0.001** |
| Fe-OC (µmol/g sediment) | 2.21 | 0.10 | ANOVA | 1.8 | 3, 46 | 0.159 |

Table S2: Games Howell post-hoc tests analyzing differences in sediment OC (% of sediment mass) among reservoir-years

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Comparison | Difference | Lower 95% CI | Upper 95% CI | p-value |
| BVR 2019-BVR 2021 | 0.41 | -0.51 | 1.34 | 0.609 |
| BVR 2019-FCR 2019 | -2.34 | -3.62 | -1.06 | **<0.001** |
| BVR 2019-FCR 2021 | 1.70 | 0.27 | 3.13 | **0.017** |
| BVR 2021-FCR 2019 | -2.75 | -4.13 | -1.37 | **<0.001** |
| BVR 2021-FCR 2021 | 1.28 | -0.23 | 2.80 | 0.116 |
| FCR 2019-FCR 2021 | 4.04 | 2.32 | 5.76 | **<0.001** |

Table S3: Tukey post-hoc tests analyzing differences in Fe-OC (% of sediment OC) among reservoir-years

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Comparison | Difference | Lower 95% CI | Upper 95% CI | p-value |
| BVR 2021-BVR 2019 | -6.61 | -13.94 | 0.73 | 0.091 |
| FCR 2019-BVR 2019 | 7.28 | 0.08 | 14.47 | **0.046** |
| FCR 2021-BVR 2019 | -3.73 | -11.06 | 3.61 | 0.534 |
| FCR 2019-BVR 2021 | 13.89 | 8.39 | 19.39 | **<0.001** |
| FCR 2021-BVR 2021 | 2.88 | -2.80 | 8.56 | 0.535 |
| FCR 2021-FCR 2019 | -11.00 | -16.50 | -5.51 | **<0.001** |

Table S4: Levene tests assessing homogeneity of variance among microcosm treatments at the end of the experiment (days 20 and 23)

|  |  |  |  |
| --- | --- | --- | --- |
|  | df | Levene statistic | Levene p-value |
| Fe-OC (% of sediment OC) | 3, 20 | 0.39 | 0.76 |
| OC (% of sediment mass) | 3, 20 | 2.81 | 0.065 |
| Fe-OC (µmol/g sediment) | 3, 20 | 0.51 | 0.68 |

Table S5: Log activity (molal) of Fe species in each of four treatments on day 23 day of the microcosm experiments. Speciation calculations conducted using SPECE8 module of Geochemist's Workbench, using the wateq4 thermodynamic database. Bolded values show the top 5 highest activities for each condition.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Hypoxic | Hypoxic to oxic | Oxic to hypoxic | Oxic |
| Fe++ | -3.7599 | -14.9723 | -14.0942 | -14.223 |
| FeHCO3+ | -4.8094 | -16.7332 | -15.5919 | -16.0846 |
| FeCO3 | -5.8983 | -17.7821 | -16.6208 | -17.3635 |
| FeOH+ | -6.3186 | -17.5723 | -16.6742 | -17.053 |
| FeSO4 | -6.4408 | 17.1044 | -15.9887 | -15.9106 |
| Fe(OH)2+ | -7.1404 | -6.1546 | -5.7579 | -5.632 |
| Fe(OH)3 | -7.2287 | -6.1446 | -5.7279 | -5.852 |
| FeCl+ | -8.0724 | -18.7584 | -18.4746 | -18.4399 |
| Fe(OH)4- | -9.4087 | -8.2846 | -7.8479 | -8.222 |
| FeOH++ | -10.5786 | -9.5746 | -9.1979 | -8.822 |
| Fe(OH)2 | -10.6099 | -21.7423 | -20.8242 | -21.453 |
| FeHumate+ | -11.2688 | -10.6659 | -9.8711 | -9.7085 |
| FeHSO4+ | -12.483 | -23.1866 | -22.0909 | -21.7628 |
| Fe(OH)3- | -14.1799 | -25.2723 | -24.3342 | -25.213 |
| Fe+++ | -15.2486 | -14.2846 | -13.9278 | -13.302 |
| FeSO4+ | -16.1395 | -14.6267 | -14.0324 | -13.1996 |
| FeCl++ | -18.2211 | -16.7307 | -16.9682 | -16.1788 |
| Fe2(OH)2++++ | -19.7273 | 17.7192 | -16.9657 | -16.214 |
| Fe(SO4)2- | -19.7305 | -17.6688 | -16.8369 | -15.7972 |
| FeCl2+ | -22.0236 | -20.0068 | -20.8385 | -19.8857 |
| FeHSO4++ | -22.5717 | -21.0989 | -20.5246 | -19.4418 |
| Fe3(OH)4+++++ | -24.6059 | -21.5538 | -20.4036 | -19.5259 |
| FeCl3 | -27.476 | -24.9329 | -26.3589 | -25.2426 |
| Fe(HS)2 | -85.2473 | -290.9054 | -281.5707 | -288.86 |
| Fe(HS)3- | -128.4289 | -300 | -300 | -300 |

Jars of food on a table

Description automatically generated with medium confidence

Figure S1: Photo illustrating experimental microcosm set-up, with visual differences between treatments on day 13 of the experiment. Left: an oxic microcosm. Right: a hypoxic (sealed) microcosm.

Chart, box and whisker chart

Description automatically generated

Figure S2: Volume-weighted hypolimnetic oxygen concentrations during the summer stratified periods (June–October) of 2014–2021 in Falling Creek Reservoir (FCR) and Beaverdam Reservoir (BVR). Boxplots present the median, 75th quartile, and 25th quartile of dissolved oxygen concentrations that have been interpolated to a daily timestep. Gray shading highlights the focal years for this study (2019 and 2021).

Chart, scatter chart

Description automatically generated

Figure S3: Correspondence between measured dissolved organic carbon (DOC) and measured total organic carbon (TOC). Diagonal line represents a 1:1 relationship between DOC and TOC. Linear regression results are shown by the blue line, with the equation and R2 of the regression presented in the top right corner.

Calendar

Description automatically generated

Figure S4: Experimental oxygen treatments led to differences in the concentrations of many elements. Data graphed here are unfiltered samples from microcosms sampled on day 16 (red) and 23 (blue). The x-axis represents experimental treatment, where aa = Hypoxic, ao = Hypoxic-to-oxic, oa = Oxic-to-hypoxic, and oo = Oxic. Each panel is labeled with the elemental abbreviation, followed by the isotope measured.

Chart, scatter chart

Description automatically generated

Figure S5: pH remained circumneutral across all experimental treatments throughout the duration of the microcosm incubations. Vertical lines indicate when experimental treatments were switched, creating the Oxic-to-hypoxic and Hypoxic-to-oxic treatments.

Chart

Description automatically generated

Figure S6: Hypolimnetic pH remained circumneutral (6–8) in the hypolimnia of both Beaverdam (BVR) and Falling Creek (FCR) Reservoirs throughout the duration of this study (2019 and 2021).