Aquatic Recovery Following a Megafire: Examining Spatial and Temporal Patterns in Water Quality

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Introduction

- In Fall of 2018, 610 km burned in the Mt Nebo part of the Utah Lake Watershed, part of a new fire regime with larger and more disastrous effects (Keeley et al 2009)
- Megafires restructure the landscape drivers of water chemistry and nutrient retention threatening ecosystem services
- Ecosystem services such as nutrient retention and riparian buffers altered by fires could create hyper-eutrophic (nutrient rich) conditions in downstream water bodies

Methods

- Sampling of over 90 rivers and streams has been done almost monthly following the late 2018 Nebo Megafire
- Samples were collected and analyzed for a suite of water quality parameters
- Watershed catchments were analyzed, and samples collected to better see the stability and scale of nutrient transformation
- Non-parametric Mann Whitney U tests were used to compare water quality parameters from two dates approximately one year apart (6 months – May 9, 2019 and 18 months – April 30, 2020, post burn)
- Univariate and Bi-variate Local Moran's I Analysis were used to locate any statistically significant clusters of high or low values in water quality parameters on both dates individually and whether any clusters were consistent between dates. This approach uses Euclidean distance to try and determine the influence of the watershed burn characteristics on water quality parameters

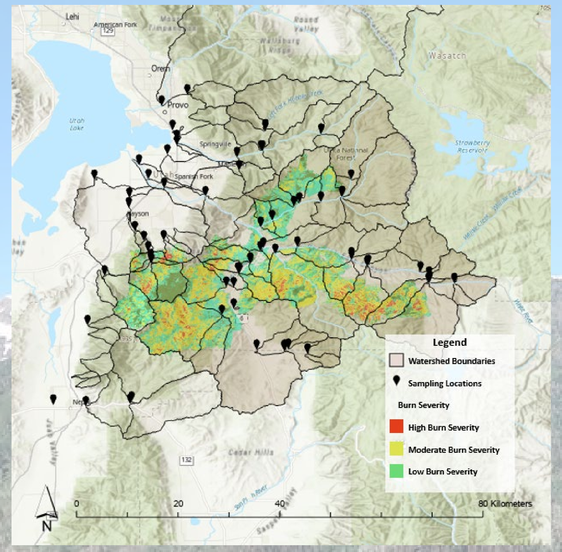

Figure 1. Map of watershed boundaries, sampling locations and soil burn severity

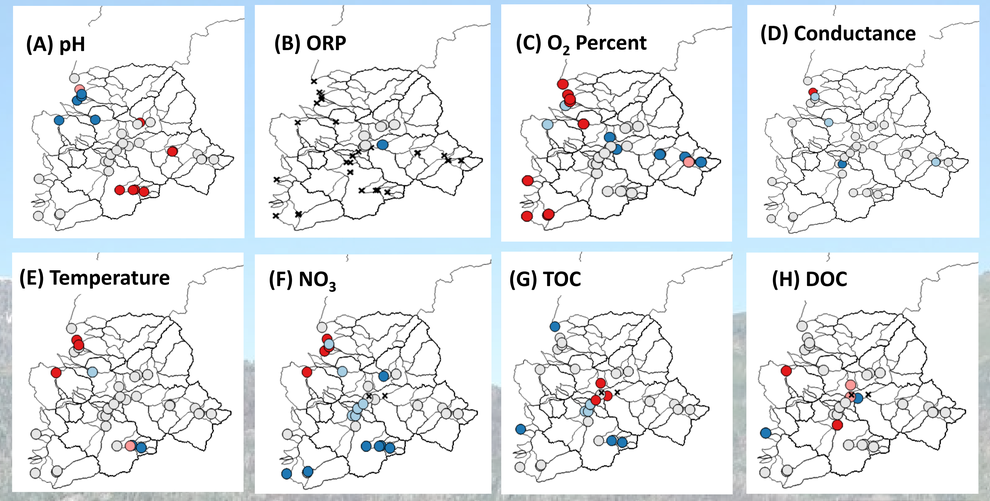

Figure 2. Bivariate Local Moran's I Maps for Water Quality Parameters in the Nebo Fire Watersheds Post-fire in 2019 and 2020

Results

Mann Whitney U Test Results and Spearman Rank Correlation Coefficients with 2019 and 2020 Water Chemistry Parameters

Test Variables	Hypothesized Relationships	Year with highest ranks	p value	Correlation Coefficients
pH	Decrease for many years post burn, results inconsistent (Baley et al. 1992, Bitner et al 2001)	2020	0.000	0.220
ORP (Oxidation Reduction Potential)	Influenced by nutrient concentrations and discharge events	2020	0.021	0.600
O_2 Percent	Related to temperature increases post burn (Betts & Jones 2009)	2019	0.000	0.153
Conductance (dS cm^{-1})	Increase post burn, duration depends on severity	2019	0.029	0.579
Temperature (°C)	Increase for many years post burn (Rhoades et al. 2011, Bitner et al. 2001, Rust et al. 2019)	2020	0.000	0.486
NO_3 (eq)	Increase up to 250-fold post burn, duration varies	2020	0.012	0.396
TOC (eq)	Increase in moderately burned catchments, durations subject to severity (Rhoades et al 2019)	2020	0.000	0.096
DOC (eq)	Increased in moderately burned catchments, durations subject to severity (Rhoades et al 2019)	2020	0.000	0.542

Table 1: Highlighted yellow values show the opposite pattern to that is expected based on cited literature sources. Though expected concentrations are listed above, there can be complex interactions such as year since previous fire, stream riparian vegetation, topography, precipitation events, land use, fire-fighting strategies, soil burn severity, and human disturbances that are not listed or cited in the literature to date. These interactions could and potentially confound the expected relationships from one year to the next.

Discussion

- Bivariate Local Moran's I analysis shows different spatial relationships between water quality parameters and the burn
- Nitrate concentrations are high in the urban environment but show LH clusters in the middle heavily burned upper catchments. This shows the expected increase in nitrate over time post burn with 2019 having lower values than 2020
- TOC and DOC, while closely related parameters show similar but different results, meaning that topography or land use must be impacting these areas differently.
- pH shows clusters of low pH (LL) near Utah lake in both years where the cumulative effects of the burn up stream are greatest
- Clusters of high temperature and nitrate levels near Utah lake likely reflect differences caused by the urban environment
- Correlation Coefficients from the Spearman's rank analysis between the two dates show ecosystem resilience. Higher values indicate the spatial persistence of the nutrients in the ecosystem

Conclusions and Future Work

- Use stream network distance instead of Euclidian distance for spatial analyses. This will overcome any spatial bias of hydrologically connected sites.
- Rerun the spatial analysis with additional data from before and after the burn.
- Use land use data to find out what is happening in post fire recovery of water quality

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