

Assessment of San Juan River Health After Gold King Mine Spill

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Abstract

One of the major environmental problems associated with surface mining is production of a highly acidic and metal-rich solution called Acid Mine Drainage (AMD). If left untreated AMD can severely damage the aquatic system. One of the biggest AMD spills in the U.S. occurred on August 6, 2015, when 3 million gallons of AMD water was accidentally released into the Animas River from abandoned Gold King Mine located outside of Silverton, Colorado. The spill temporarily changed the color of the river to orange. The contaminated water flowed down the Animas River, into the San Juan River in New Mexico, was carried into the Colorado River and ended up in Lake Powell in Utah. The Navajo Nation Commission on Emergency Management issued a state of emergency declaration in response to the spill. The effects of the Gold King Mine spill on the Navajo Nation have included damage to their crops, home gardens, and cattle herds which ceased irrigating their crops from the San Juan River. People living along the Animas and San Juan rivers were advised to have their water tested before using it for cooking, drinking, or bathing. The spill was also expected to cause major problems for farmers and ranchers who rely on the rivers for their livelihoods. The long-term impacts of the spill are unknown, as sedimentation is expected to dilute the pollutants as the spill cloud moves downstream. This study conducted a desk-top evaluation of stream "health" in the San Juan River system that crosses the state lines of Colorado, New Mexico, Utah, and Arizona and flows through tribal lands. In 2016, benthic invertebrate surveys were conducted at San Juan River monitoring sites in the Navajo Nation, and those data are available to the public. Biological indices were calculated using these benthic invertebrates following the guidance of each state's regulatory agencies, and the results were compared to evaluate how the sites would be classified in terms of "impairment" by each state's bio criteria method. Our results showed the nature of resiliency from the microorganisms over the time and their recovery trend.

Introduction

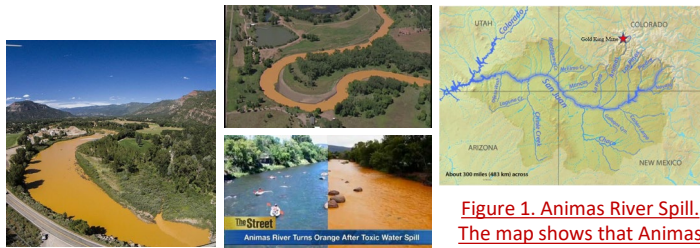


Figure 1. Animas River Spill. The map shows that Animas River is connected to San Juan River, NM.

Methods

- This study used publicly available data from the USEPA Gold King spill monitoring project.
- The sampling data used in this study were from August and September 2016.
- Four of the USEPA sampling sites along the San Juan River were selected for this study: SJAR (upstream Animus River), SJ4C (Four Corners, NM), SJSR (Shiprock, NM), and SJLP. (downstream Animus River, near Farmington, NM).
- Bioassessment methods used in Colorado and New Mexico both rely on invertebrate datasets with taxonomic hierarchy, species count (from the EPA samples), regional tolerance values, functional feeding group designations, and habit/behavior assignments.
- For the metrics, it was assumed that "Intolerant Taxa" = Taxa with TV < 3.
- Hilsenhoff Biotic Index Formula = $\sum \frac{n_i \times t_i}{N}$
Where, n_i is number of individuals of the i^{th} taxon
 t_i is the tolerance value of that taxon and
 N is the total number of individuals in the sample.
- Shannon Weiner Index Formula = $\sum p_i \times \ln p_i$
Where, p_i is the proportion of the entire community made up of species i



Figure 2. Sampling sites along Animas River and San Juan River.

Results

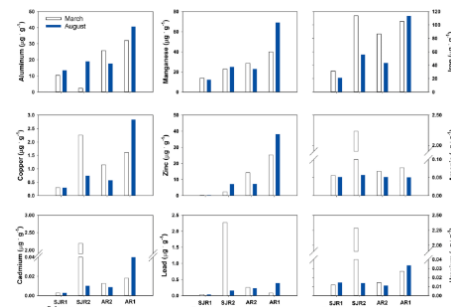


Figure 3. Effects of the Gold King Mine Spill on Metal Cycling through River and Riparian Biota across San Juan River (SJR) and Animas River (AR) basins. (Deval et al., 2020)

Metal	Pounds	Metal	Pounds	Metal	Pounds
Iron	248,582	Copper	919	Cobalt	10
Aluminum	23,657	Sodium	586	Antimony	8
Calcium	11,365	Barium	244	Nickel	7
Magnesium	6,984	Arsenic	206	Mercury	6
Potassium	5,307	Vanadium	137	Cadmium	4
Lead	4,481	Molybdenum	50	Beryllium	3
Manganese	1,953	Silver	28	Selenium	n.d.*
Zinc	1,101	Chromium	18	Thallium	n.d.*

Table 1. Weight of metals (in pounds) released in of acid mine drainage from Gold King Mine from USEPA measurements at the Cement Creek 14th St. Bridge on Aug. 5, 2015 at 16:00 hours (US EPA, Preliminary Analytical Data, 2015).

Site	Colorado Results	New Mexico Results
SJAR August	Impaired	
SJAR September	Not Impaired	
SJLP August	Impaired	Non-Impaired
SJLP September	Attainment	Non-Impaired
SJSR August	Attainment	Non-Impaired
SJSR September	Impaired	Non-Impaired
SJ4C August	Attainment	Non-Impaired
SJ4C September	Impaired	Moderately Impaired

Table 2. Bioassessment Results

Conclusion

The ecological health of streams and rivers is often assessed by looking at freshwater invertebrates. RIVPACS models are based on a database of reference samples from streams and rivers across the San Juan River which flows into three states on the Navajo Reservation, these were collected between 2014 and 2019.

The information collected was put into a spreadsheet then categorized to Class, Order, Phylum, family, Tribe, and Genus and it was done for the New Mexico and Colorado since the river runs through the three states also Utah. The information was broken down into a final draft report to analyze the samples of species that were affected. The need to define a target community of what type of species were affected and to create a baseline for comparing results. Analyzing the data was a factor since no other information was available. The river has been impacted by disturbance from the chemicals, the flow and destroyed certain species.

Acknowledgements

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References

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