Water Quality Monitoring to Assess the Effectiveness of Restoration Activities in the Salmon Creek Watershed

Headwater Forest Reserve, Humboldt County, CA

Jennifer Turk, Brayden Leach, Malia Gonzalez, Kai Narum, Eileen Cashman, Brad Finney, and Sam Flanagan

Humboldt State University | April 2021

Introduction

The Headwaters Forest Reserve, currently managed by the U.S. Bureau of Land Management in partnership with the California Department of Fish and Game, is approximately 7,400 acres, including 3,000 acres of spectacular old-growth redwood forest (Figure 1). One of the primary management goals for the Headwaters Forest Reserve is the protection of threatened species and their habitats. A water quality gauging station was established in September of 2011 to assess the effectiveness of watershed restoration activities (including road removal) within the Reserve and to characterize long-term trends in suspended sediment transport. The gauging station monitors stage and turbidity at 15-minutes intervals and collects a water sample based on a turbidity-threshold protocol (Figure 2). This poster will present the results of the analysis on data from the Salmon Creek watershed for WY 2020.

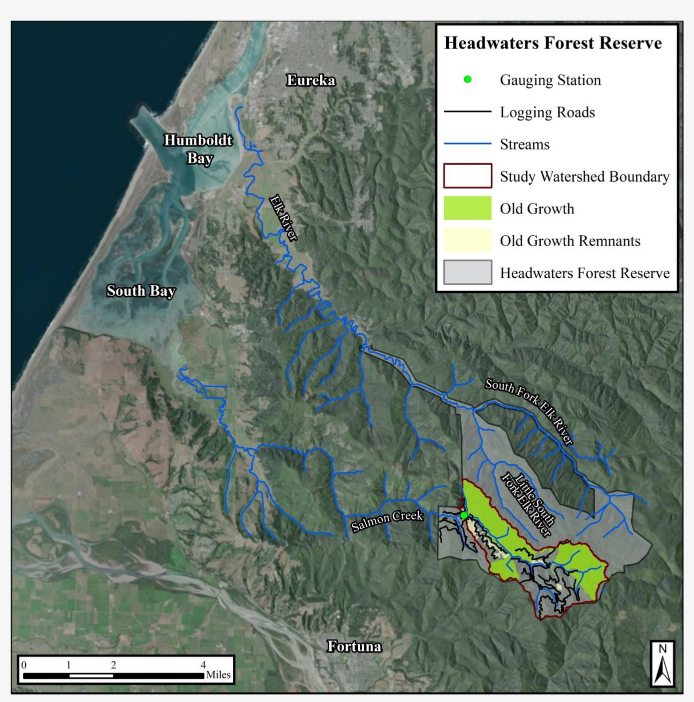

Figure 1: Map of Salmon Creek Watershed with the Headwaters Forest Reserve highlighted in grey. The gauging station is the green dot.

Figure 2: The gauge site during a high flow event. The turbidity probe in circled in orange and the station containing the equipment is circled in yellow.

Methods

A stage discharge rating is developed by relating stage measurements collected via a pressure transducer at 15-minute intervals to stream discharge using a Swoffer flow meter at an established cross-section.

A relationship between turbidity and suspended sediment concentration is developed by relating turbidity measurements collected at 15-minute intervals to collected water samples analyzed for suspended sediment. Water samples are taken when the data logger detects turbidity greater than a pre-set threshold (currently 100 NTU) and rising over two or more intervals.

Total sediment load over a given time period is calculated using Equation 1 below (USGS 1972).

$$M_s = Q * SSC * t \qquad (1)$$

M_s = sediment discharge in time interval (mg)

SSC = mean sediment concentration for time interval (mg/L)

Q = mean water discharge for time interval (L/hour)

t = duration of time interval (hours)

Results

The results from the analysis of data collected during the 2020 WY are presented here. The peak discharge and turbidity for the WY were 62 cfs and 1077 NTU, respectively (Figure 3). The cumulative precipitation for the entire WY (only part of the WY is shown below) was 31 inches which is 67% of normal. The total sediment transported past the Salmon Creek station was 146 tons.

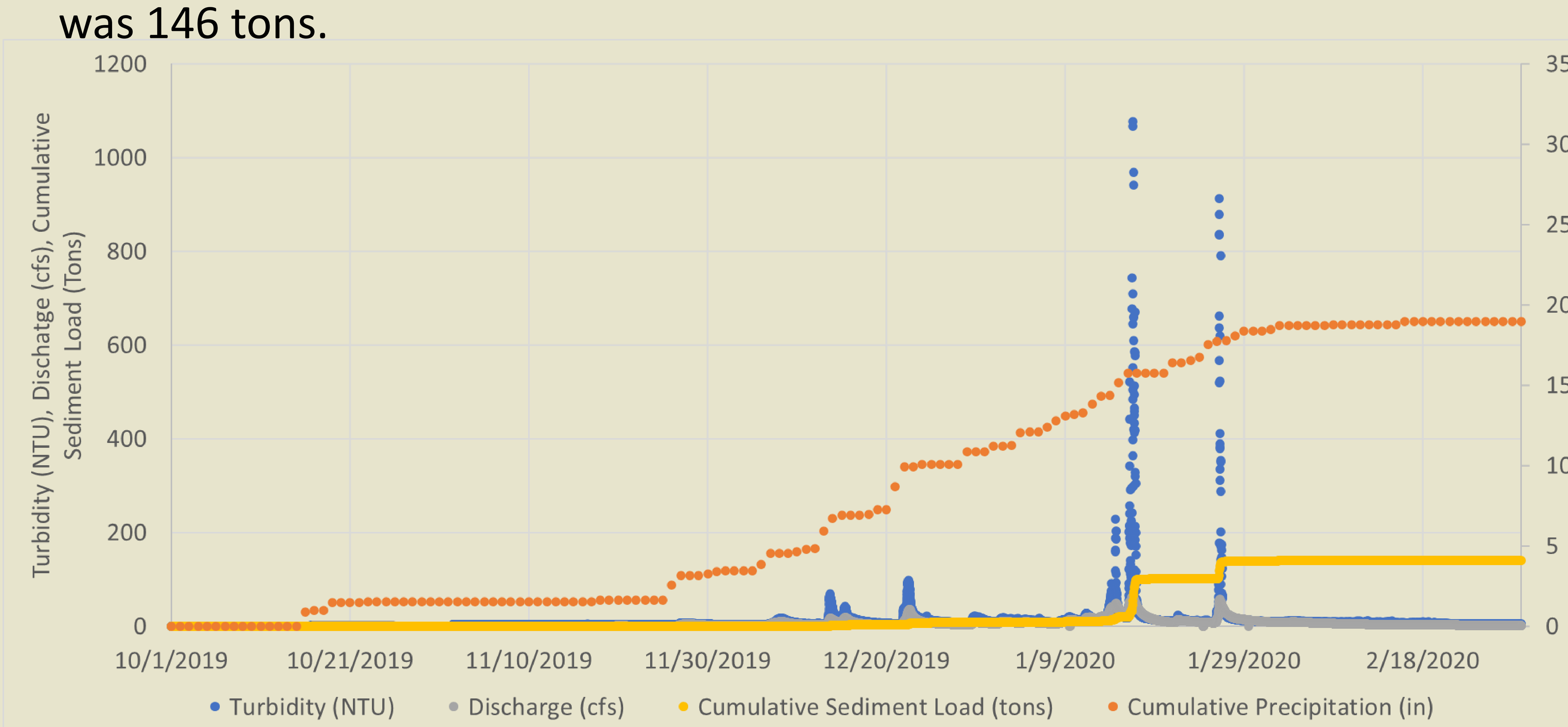

Figure 3: Summary of the available site data and analysis for the 2020 water year. The discharge from Salmon Creek is shown in grey, turbidity in blue, cumulative sediment in yellow, and cumulative precipitation in orange.

Three storms over the course of the WY accounted for 82% of the total sediment transported in the WY (orange in Figure 4). Storm 2, which occurred between January 12th and 18th, contributed 83 tons of sediment or 57% of the total sediment transported in the WY (Figure 5).

The strong relationship between SSC and turbidity was the basis for the calculation of the total sediment discharged from the watershed for the 2020 WY (Figure 6).

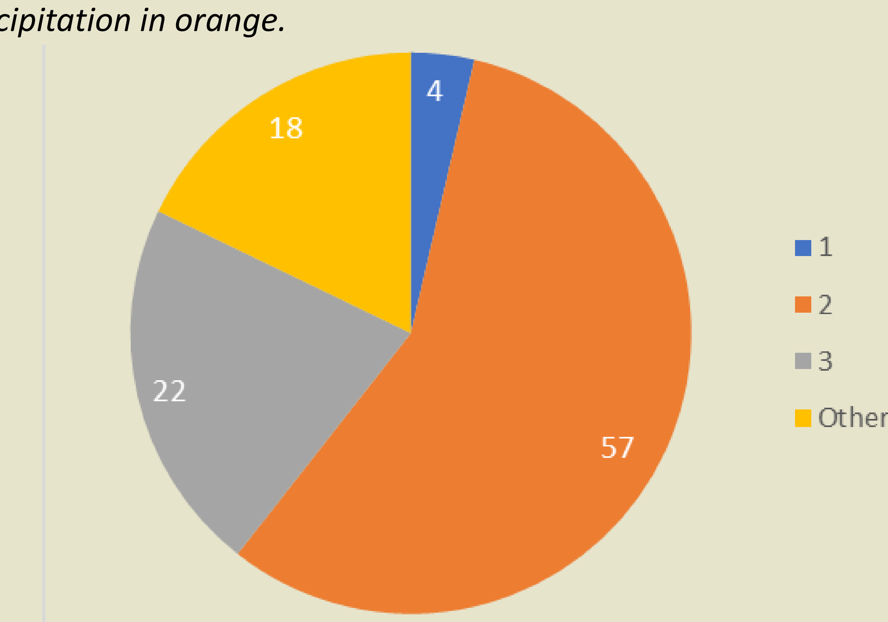

Figure 4: Distribution of sediment discharged from the watershed during WY 2020. Storm 2 produced the most sediment discharge for the entire year.

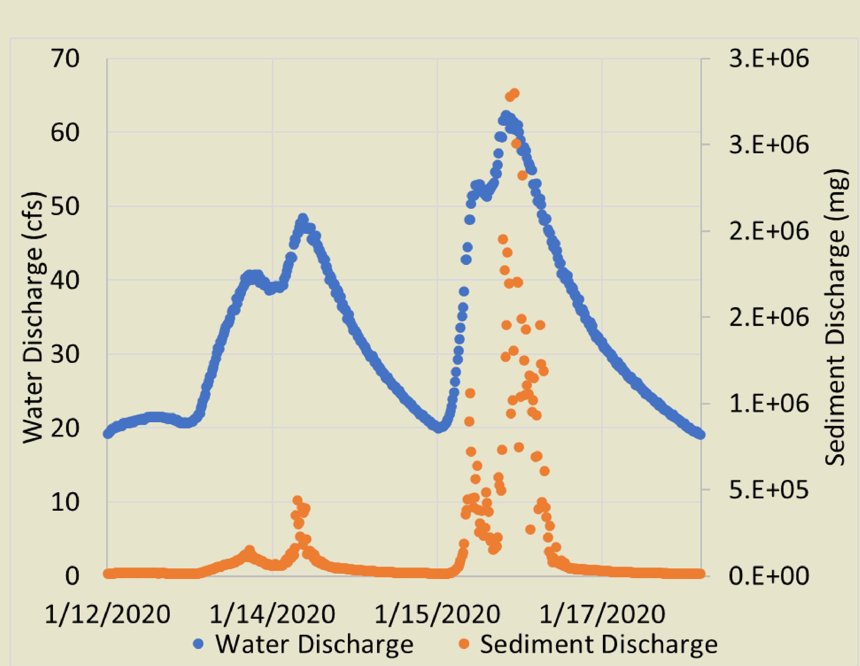

Figure 5: Hydrograph and sedigraph for storm 2 which accounted for 57% of the sediment discharged in WY 2020.

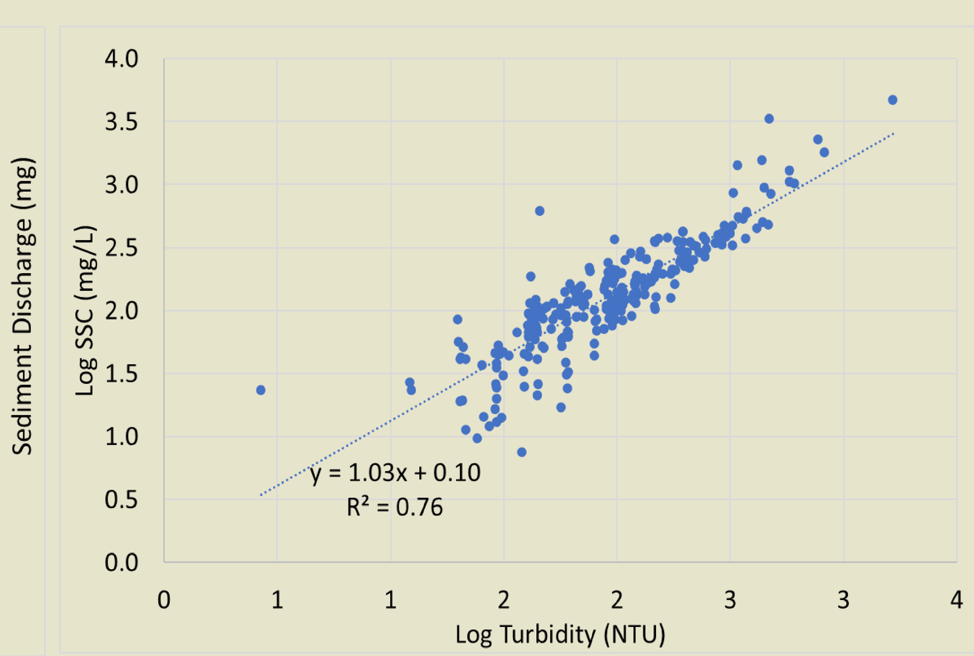

Figure 6: Sediment-turbidity relationship using data from all years that was used to determine the total sediment load discharged from the watershed in the 2020 water year.

Discussion

The majority (57%) of the sediment load transported in the 2020 WY is produced during a single storm event (Figure 5). Of that storm event, the highest turbidity values and discharge occurred in less than a 24-hour period, with the rest of the period classified as a storm having moderate sediment transport values. While a stage-discharge rating curve must be re-established each year, the sediment-turbidity relationship remains constant throughout the years (Figure 6). This is expected because the channel geometry at the station x-section experiences significant erosion and deposition events, but the geological conditions that impact sediment supply are not changing over time.

The total sediment discharged in a WY is weakly related to the peak discharge that occurs in that WY (Figure 7), while the peak turbidity has a larger variance. Further research is being conducted to understand how precipitation intensity may more strongly impact the sediment transported.

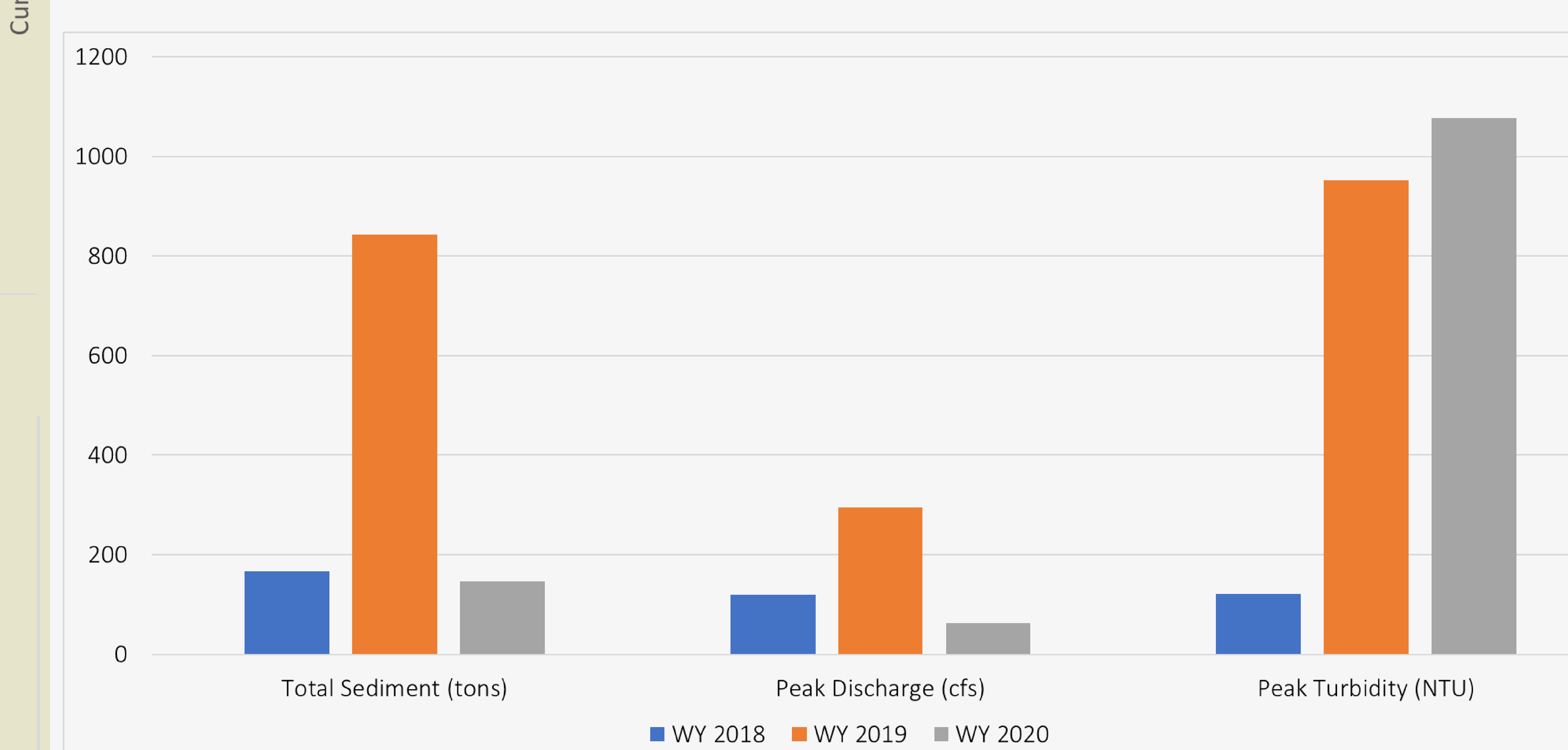

Figure 7: Total sediment discharge, peak discharge and peak turbidity WY's 2018 (blue), 2019 (orange), and 2020 (grey).

Conclusion

The results for WY 2020 suggest the importance of further understanding the hydrologic dynamics of storm events. A single storm in January accounted for 57% of the total sediment transported for the year and 82% of the sediment was transported in three storms. The peak turbidity and peak discharge both occurred during the same storm event, Storm 2, which transported the majority of the sediment in WY 2020. Data from the previous three water years show a weak relationship between peak discharge and total sediment transport, and a large variance in the turbidity and sediment load relationship. Additional research is being done to understand how precipitation intensity may be more strongly related to sediment transport than discharge.

References

USGS. (1972). United States Geological Survey Techniques of Water Resources Investigations. Book 3, Chapter C1, p. 49-50.