Seasonal Range of Conductivity in the Dry Creek Experimental Watershed

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Abstract

To better understand the relationship between electrical conductivity and the seasonal changes that occur within the Dry Creek Experimental Watershed (DCEW) near Boise, ID, measurements of electrical conductivity (EC), temperature, and pH were taken in 3 locations that represent the upper, middle, and lower sections of the watershed within a 24-hour period. The DCEW serves as a laboratory for research and education operated by Boise State University (BSU). An electrical conductivity meter, alcohol filled thermometer, pH meter, and pH paper were used as instrumentation for measurements. In order to find a seasonal range of conductivity, measurements were taken in November of 2021 and compared to historical data from mid-September through mid-November of 2020, collected by Boise State University. The data was then used to generate graphs for further analysis. The results revealed relatively low conductivity levels, and pH values that were neutral to slightly alkaline, indicating low concentrations of dissolved nutrients. However, in order to draw comparisons between data from 2020 and 2021, the use of a comparable continuous data logger would be necessary to relate temperature and electrical conductivity.

Research Question

What is the seasonal range of electrical conductivity in the Dry Creek Experimental Watershed near Boise, Idaho? How does conductivity vary with elevation and temperature during the September to November season? Specific conductance can be influenced by water quality parameters such as temperature and pH. If temperature and pH influence the biological and chemical processes that occur within a body of water, then the natural fluctuation in temperature that occurs throughout annual seasons at different elevations could produce variability in electrical conductivity measurements. It is expected that conductivity will increase as elevation decreases and will decrease during the fall (September through November), with decreases in air temperature. Electrical conductivity, temperature, and pH, are important water quality parameters that indicate the condition of a body of water. Baseline monitoring is important as changes in the condition of a body of water, such as streams, can indicate a source of additional substances and nutrients that may pollute waters, creating implications for the ecosystem in which the stream is a part of. To identify a range of electrical conductivity within the DCEW, historical data from 2020 was retrieved from Boise State University and compared to field measurements in 2021. Field measurements of electrical conductivity, temperature, and pH were collected in the upper, middle, and lower sections of the watershed. As elevation varies in the watershed so does climate, geology, soils, and vegetation, which also can influence electrical conductivity, but these factors were beyond the scope of this semester-long GLOBE investigation.

Introduction

Specific conductance, also referred to as electrical conductivity, can be defined as the ability of water to conduct electrical current over a defined area (Brooks et al. 2013). Water alone is a poor conductor of electricity; however, ions from a specific substance present in water makes it capable of conducting an electrical current. Electrical conductivity indicates the amount of total dissolved solids in a body of water, which affects biological and chemical condition. The specific conductance of water is influenced by geographic location and temperature. Factors such as climate, geology, and land use, have an impact on conductivity in a specific region (Brooks et al. 2013).

The electrical conductivity measurements taken in DCEW at three elevations in 2021 were compared to the data collected hourly during the months of September to November, 2020 by BSU. Values that exceed the range of conductivity in 2020 could indicate an additional source of pollutants, such as nutrients, sediment and road salt. Understanding how sediment and nutrient (or constituent) concentrations vary with land use is critical to understanding the current and future impact of land use change on aquatic ecosystems (Bartley et al. 2012). The most notable land uses in DCEW are recreation and grazing which occurs across all elevations of the watershed. The nearby Bogus Basin road is maintained year-round; this includes the use of road salts. Baseline water quality monitoring can help identify impacts from land use. Increased urbanization and transportation are associated with greater emission of pollutants such as road salt; these enter the water ecosystems with surface runoff, degrading the quality of water and soil (Szlarek et al. 2021). The Dry Creek Experimental Watershed is located on the traditional lands of the Shoshone, Bannock, and Paiute tribes.
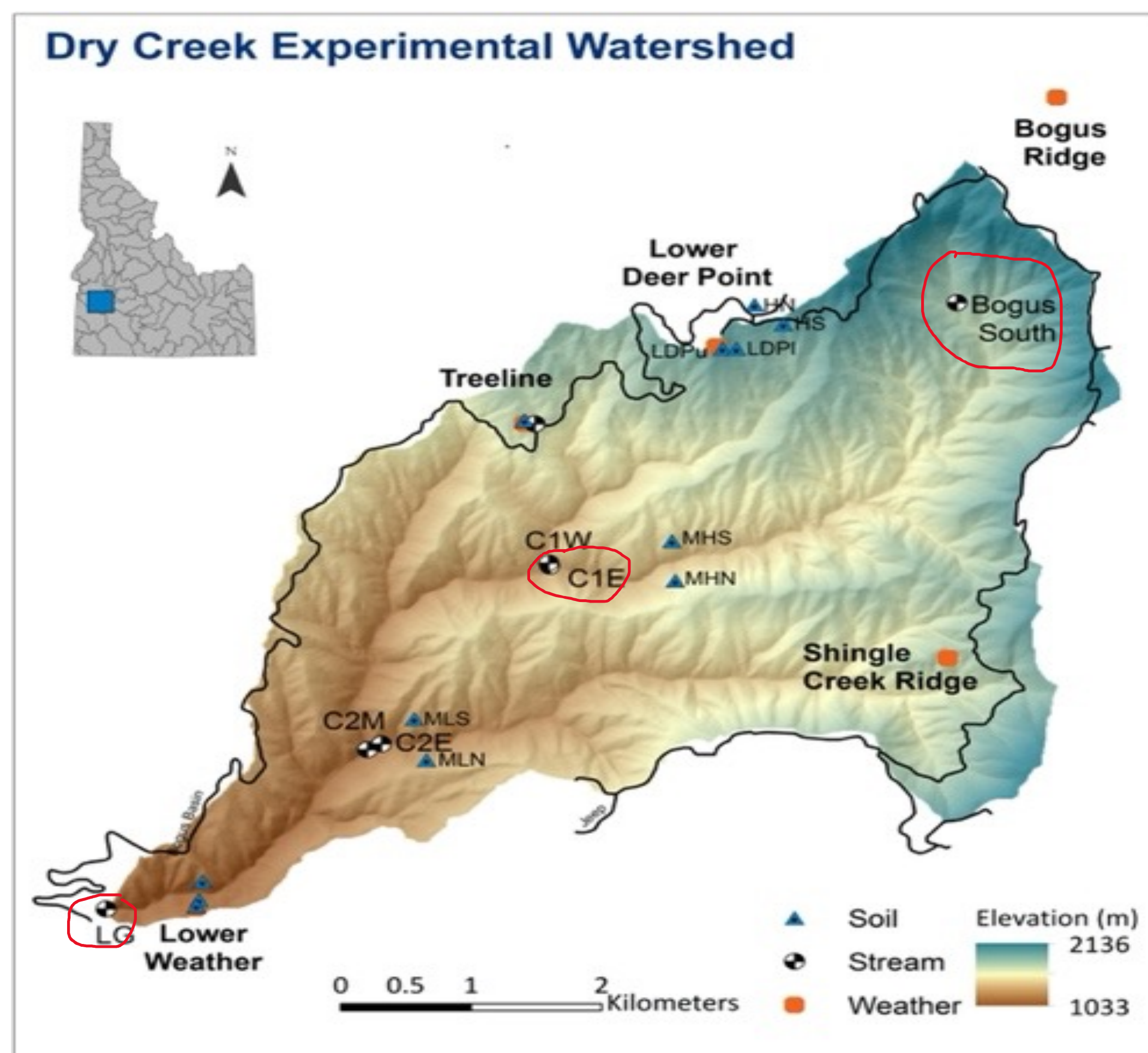
Credit: Boise State University

Research Methods

The Dry Creek Experimental Watershed is located approximately 16 km northeast of the city of Boise. The topography includes mountains and foothills, which are part of the Boise Front. The headwater uplands elevation is over 2,100 m, with stands of Ponderosa pine and Douglas fir, and areas of Lodgepole pine and Aspen, understory is brush and grass. The lower elevations are around 1,000 m, and consist of shrublands and grasslands. The weather in this region experiences moderately cold to cold winters. Snow accumulates in the higher elevations during the winter and melts in the spring.

Field measurements of electrical conductivity, temperature, and pH were collected in DCEW on November 12 and 13 during mid-morning to early afternoon, and at 3 sites that represent the upper (Bogus South), middle (Con1East), and lower (Lower Gauge) part of the watershed. The instruments utilized for measurements include an electrical conductivity meter, an alcohol-filled thermometer, a pH meter, and pH paper. All instruments were calibrated according to the GLOBE protocols. The EC meter was calibrated in the Boise State Geoscience lab using distilled water, tap water, and a standard solution of 1,413 µS/cm. Three replications of each measurement at each site were planned, though only one measurement per site was taken due to time limitations. Water samples from all sites were gathered and the same methods for field measurements were utilized at room temperature. These measurements were repeated 3 times within one hour. In addition, previously collected hourly measurements of temperature and electrical conductivity from the Boise State Geoscience department were utilized to help identify a range of conductivity for mid-September through mid-November.

Bogus South (BS)

Lower Gauge (LG)

Con1East (Con1E)

GLOBE Badges

Collaborator- I collaborated with researchers from Boise State University Geoscience Department to prepare for field research and to analyze their data and my own.
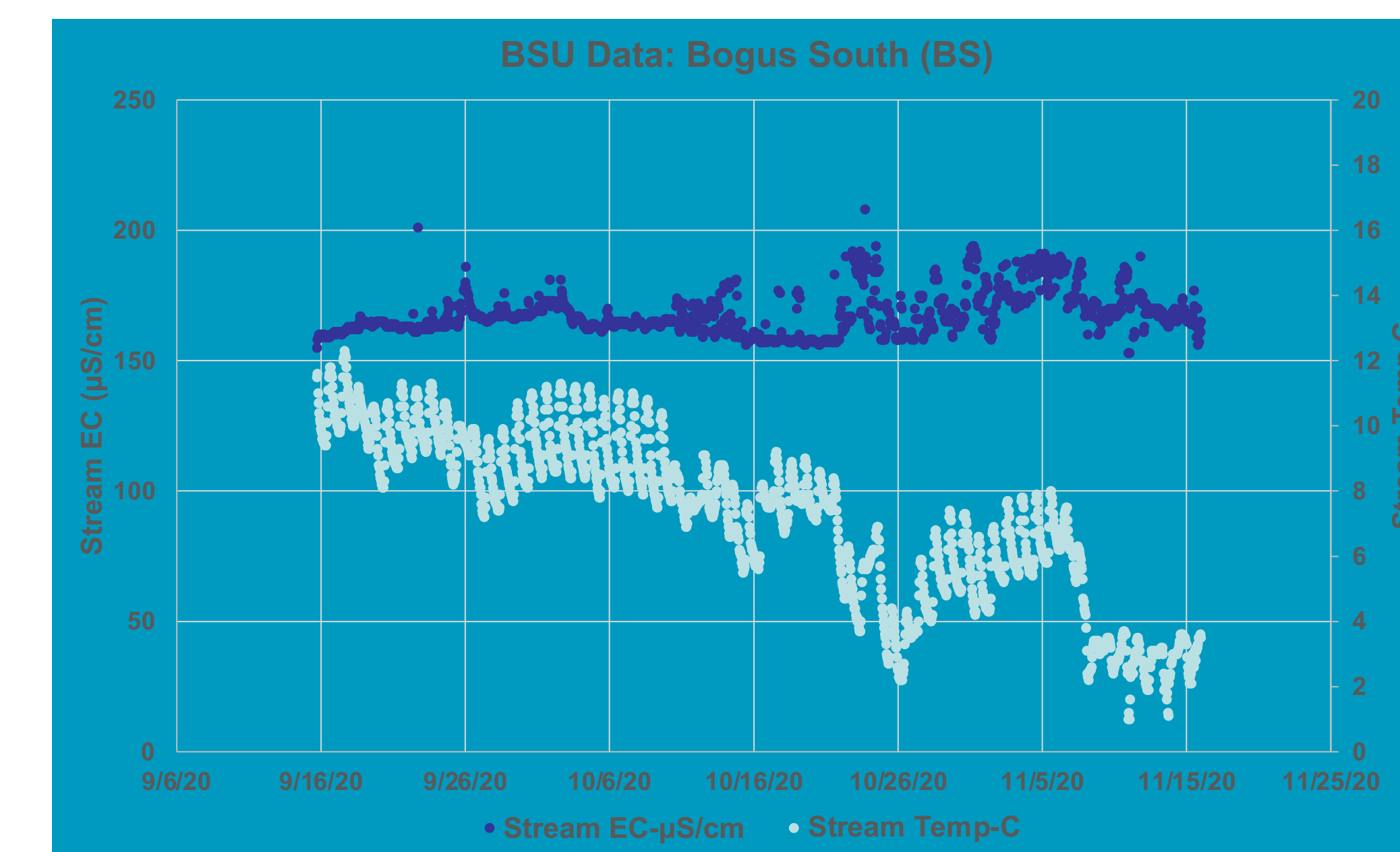
Data Scientist- I planned and conducted field research using measurements of water quality
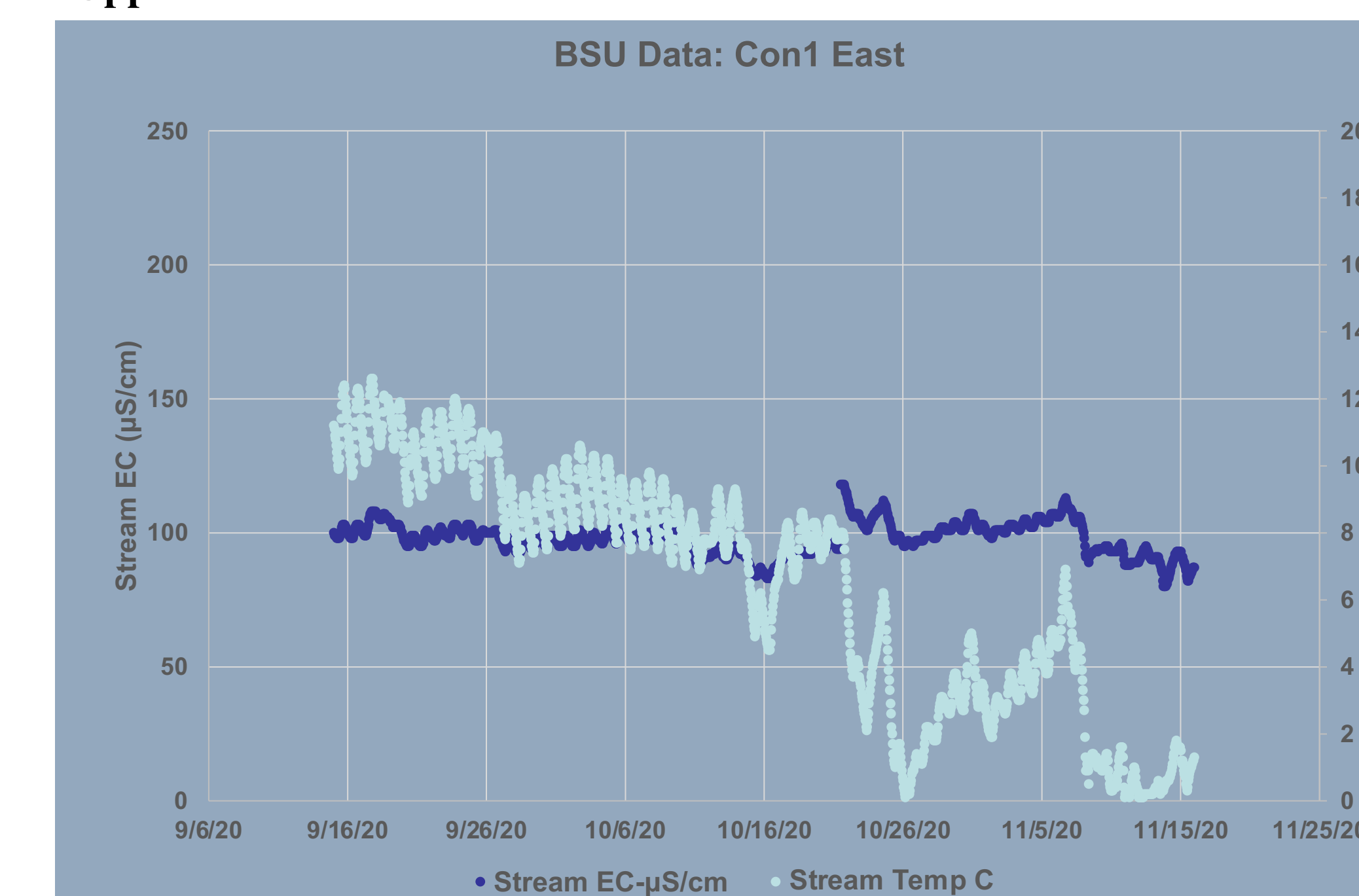
Results

2021 Data

Field Data					Room Temperature Means			
	Temp C	EC (µS/cm)	pH	pH paper		Temp C	EC (µS/cm)	pH	pH paper
BS	4	158	8	8.5	BS	21	185.6	7.6	8
Con1E	3	166	7.8	8	Con1E	21	197	6.8	7.5
LG	5	180	8	8.5	LG	21	209.3	7.2	8

2020 Data (Boise State)

BSU Data: Bogus South (BS)
Upper

BSU Data: Con1 East
Middle

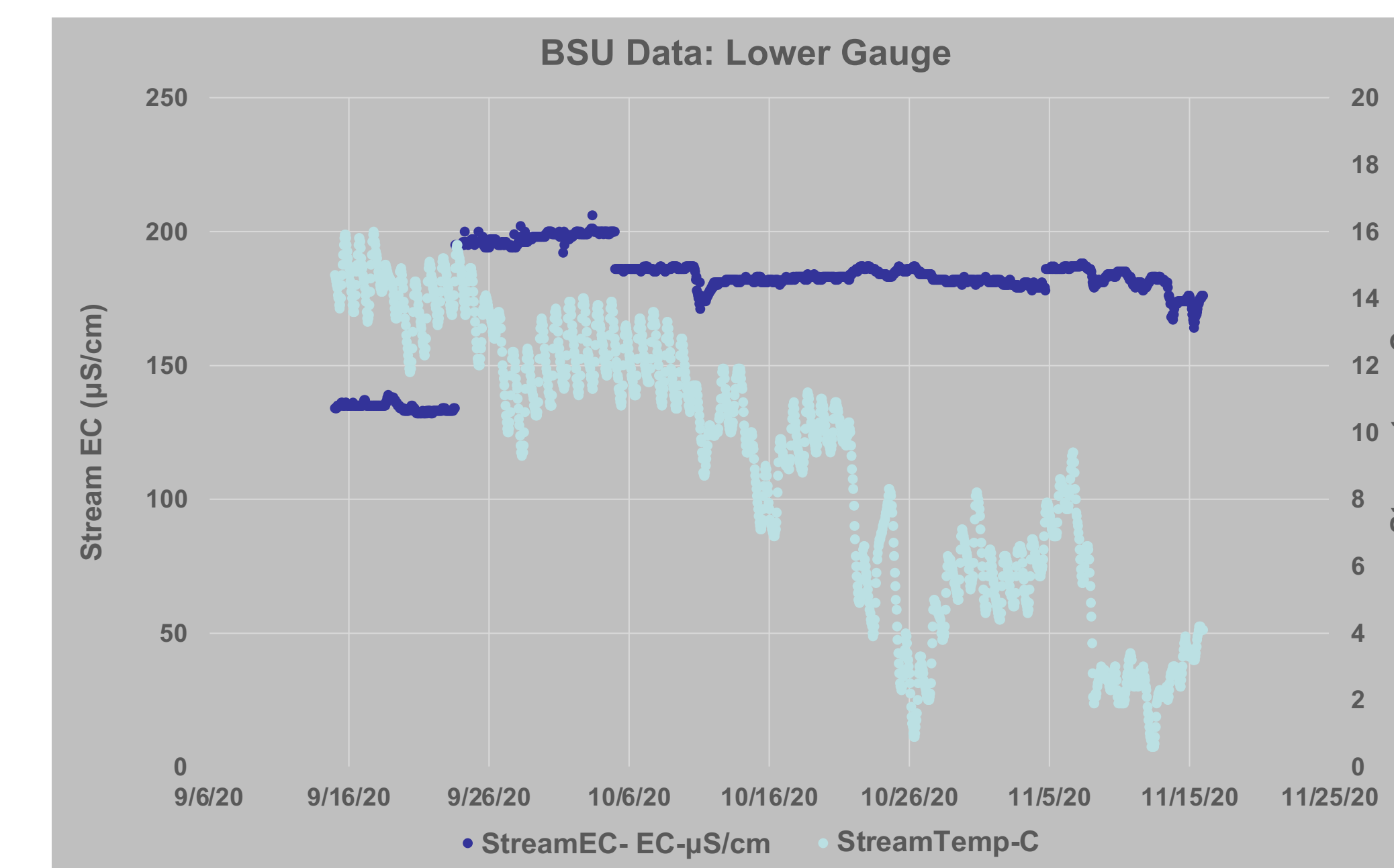BSU Data: Lower Gauge
Lower

Discussion

The data from Boise State does not fully support the hypothesis that electrical conductivity will increase as elevation decreases. The data compiled from mid-September to mid-November of 2020 indicates higher values at the top of the watershed (BS), the lowest values in the middle (Con1E), and the highest values in the lower site (LG). The data also shows a jump in EC as stream temperatures decrease, indicating a change of condition. Weather data shows a drop in air temperature in the latter part of October, and some precipitation is recorded prior to this. The change in condition could be due to an additional source, such as road salts. The highest pH values are found in the upper site (BS), and are similar to those of the lower site(LG). The lowest pH values are found in the middle site (Con1E). The parent rock material within the watershed is predominantly fractured granodiorite with minor occurrences of pegmatite.

The November 2021 measurements taken in the field and repeated with samples at room temperature do indicate an increase in EC as elevation drops, the values taken in the field do not fall outside of the range of values from the 2020 data; although the room temperature maximum value did exceed that of the 2020 data which is contributed to the increase in temperature. It should also be noted that the instrumentation used in 2021 is different from instrumentation used by BSU in 2020. Additionally, the amount of data from field measurements in 2021 is extremely limited and would require more values to determine a pattern.

Conclusions

There are higher EC values in the upper site (BS) compared to the middle site (Con1E). In the upper site (BS), stream flow is low and the stream itself is less defined, this can be compared to the middle site where stream flow increases and the stream bed is defined. The EC values in the middle site (Con1E) may be lower than those of the upper site (BS) as stream temperatures are cooler and streamflow increases. It is possible that the middle site in general experiences colder temperatures as it is in a well shaded and defined drainage. The increase in conductivity from middle (Con1E) to lower site (LG) could be from the accumulated substances in runoff from the higher parts of the watershed.

The increase in electrical conductivity when temperatures decreased may be the result of additional substances such as road salts. However, the field measurements taken were limited and insufficient to draw conclusions from. A continuous data logger would be required to further analyze the relationship between temperature and electrical conductivity. This would allow for repeated measurements and a more comprehensive analysis.

Acknowledgments

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