Seasonal Range of Conductivity in the Dry Creek Experimental Watershed

Alicia Morton
2022 GLOBE International Virtual Science Symposium
Instructor: Christina Buffington
University of Alaska Fairbanks
United States
12-3-21

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.

Water quality measurements are important for monitoring the condition of a body of water and the surrounding land. Measurements such as electrical conductivity (EC) are used to indicate the chemical and biological condition of water. The collection of data can help determine a baseline for what the normal range of conductivity in a given area is. Values that exceed this range could be indicators of additional substances that could cause pollution. Factors such as climate, geology, and land use, have an impact on water quality within a watershed and should be considered in management. Different factors, and environmental relationships could cause electrical conductivity to vary from season to season.

Research Question and Hypothesis:

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 and Review of Literature:

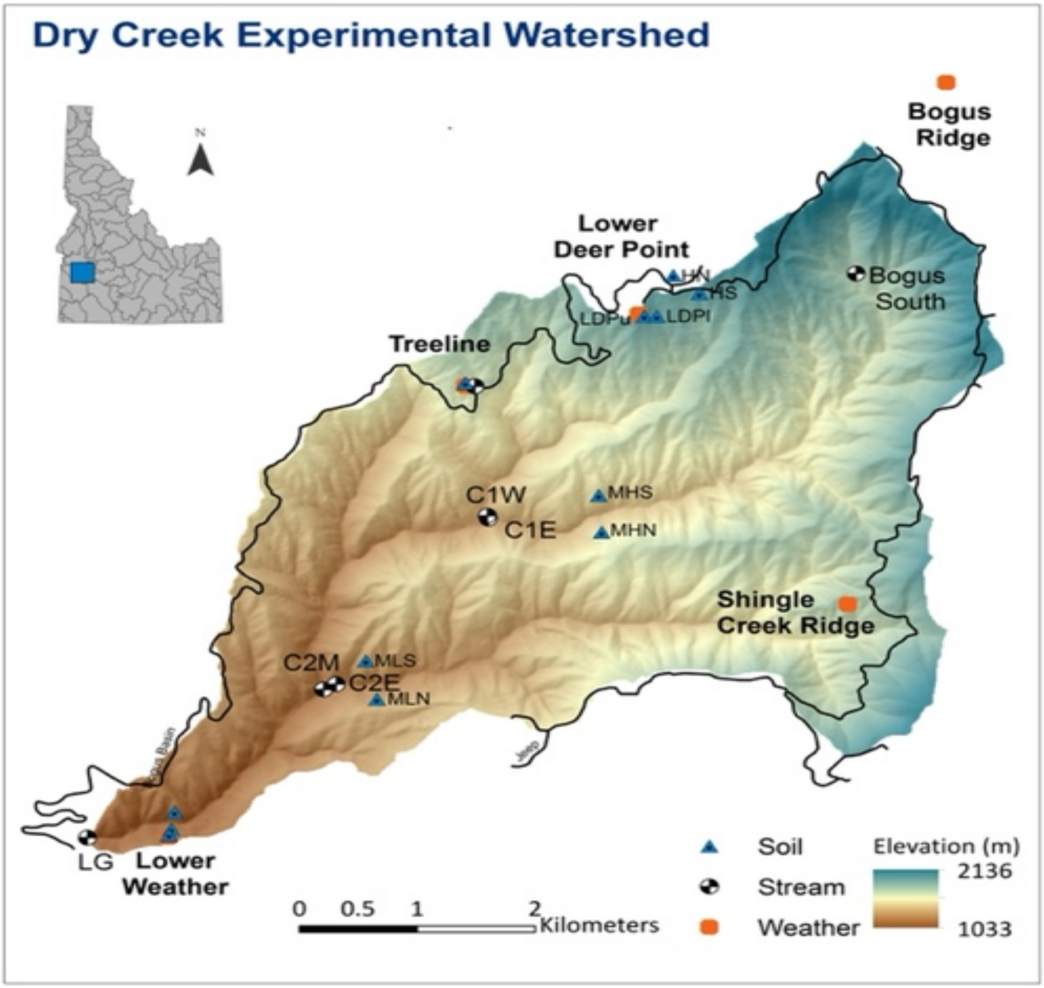
Specific conductance, also referred to as electrical conductivity, can be defined as the ability of water to conduct electrical current over a defined area (Brooks et al. 2013). Water alone is a poor conductor of electricity; however, ions from a specific substance present in water makes it capable of conducting an electrical current. Electrical conductivity indicates the amount of total dissolved solids in a body of water, which affect 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 Boise State University. 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 Shoshone-Paiute people.

Research Methods and Materials:

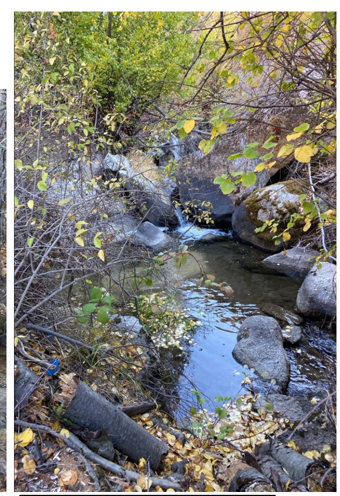
The Dry Creek Experimental Watershed is located approximately 16 km northeast of the city of Boise. The topography includes mountains and foothills, which are part of the Boise Front. The headwater uplands elevation is over 2,100 m, with stands of Ponderosa pine and Douglas fir, and areas of Lodgepole 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)

Con1East (Con1E)



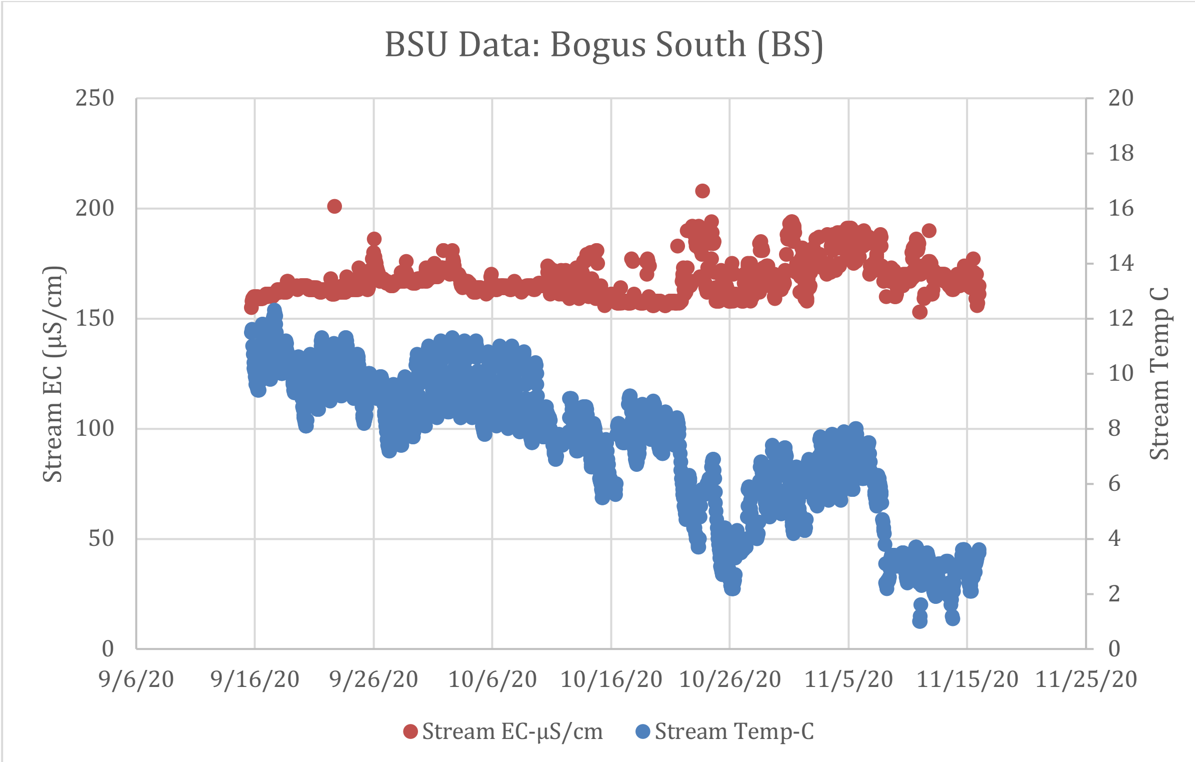
Lower Gauge (LG)

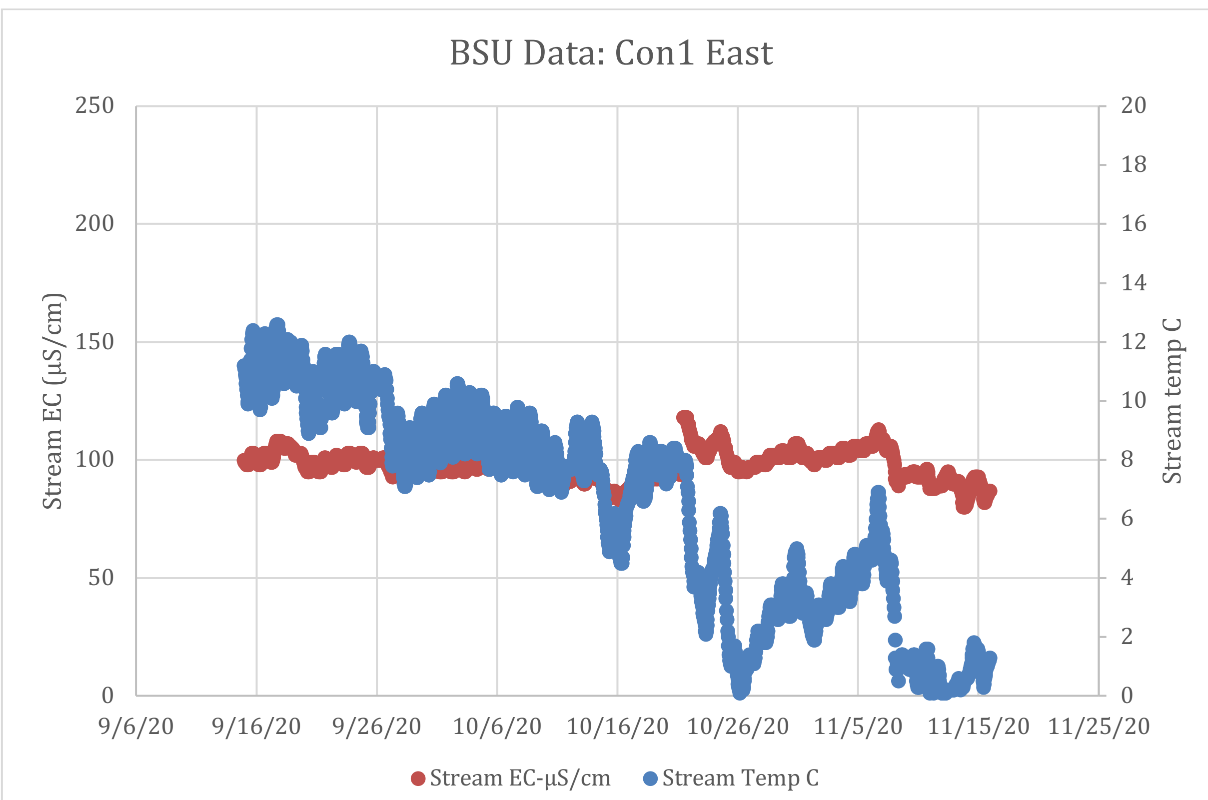
Results:

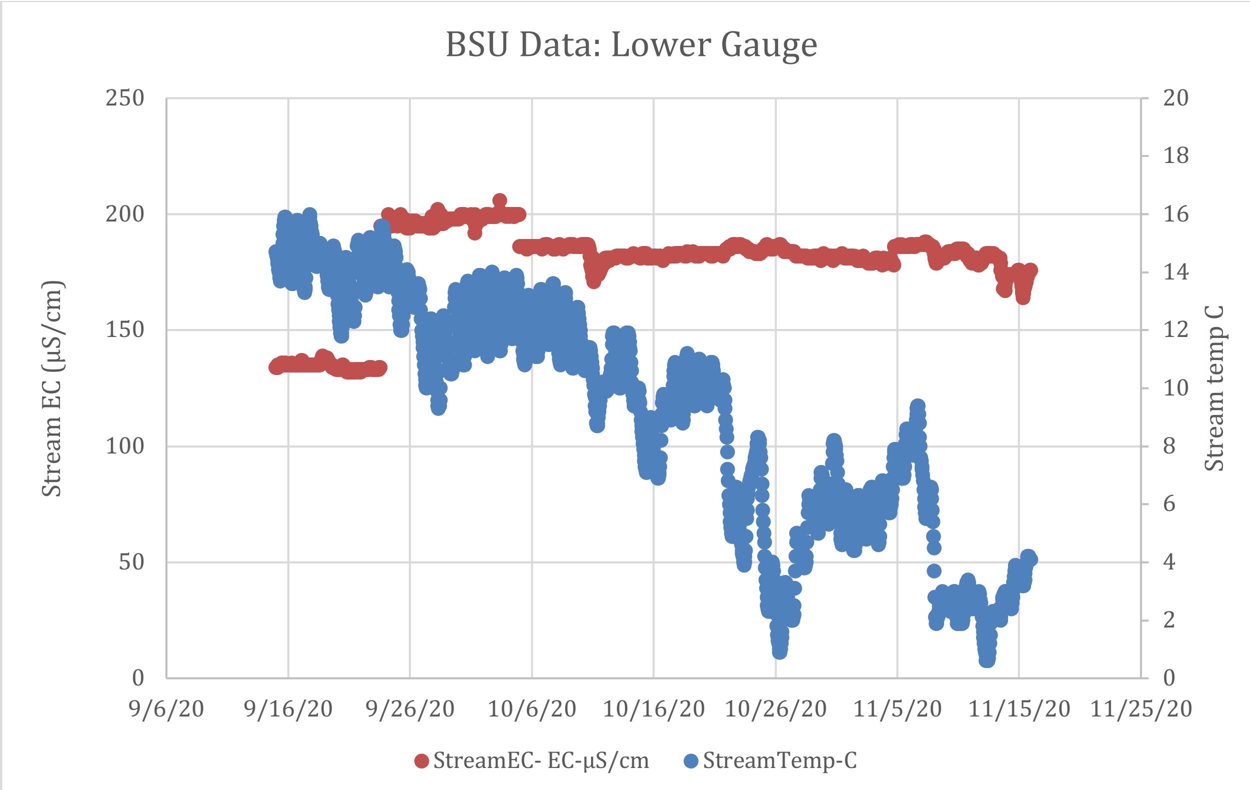
Relatively low conductivity levels were found in the DCEW. Values of electrical conductivity in both 2020 and 2021 did not exceed 210 (µS/cm). Among the measurements taken in 2021, the highest electrical conductivity values were found in the lower site (LG), and the lowest values were found in the middle site (Con1E). The lowest pH values were found in the middle site (Con1E), while the upper (BS) and lower site (LG) had identical readings. Measurements taken at room temperature decreased among all sample sites; the middle site (Con1E) decreased in pH by an entire value. The 2020 data also shows the lowest electrical conductivity values in the middle site (Con1E), and the highest values in the lower site (LG).

Field Data				
	Temp C	EC (µS/cm)	pH	pH paper
BS	4	158	8	8.5
Con1E	3	166	7.8	8
LG	5	180	8	8.5

Room Temperature Means				
	Temp C	EC (µS/cm)	pH	pH paper
BS	21	185.6	7.6	8
Con1E	21	197	6.8	7.5
LG	21	209.3	7.2	8


BSU Data: Bogus South (BS)
Stream EC (µS/cm)
Stream Temp C
250
200
150
100
50
0
20
18
16
14
12
10
8
6
4
2
0
9/6/20
9/16/20
9/26/20
10/6/20
10/16/20
10/26/20
11/5/20
11/15/20
11/25/20
Stream EC-µS/cm
Stream Temp-C


BSU Data: Con1 East
Stream EC (µS/cm)
Stream temp C
250
200
150
100
50
0
20
18
16
14
12
10
8
6
4
2
0
9/6/20
9/16/20
9/26/20
10/6/20
10/16/20
10/26/20
11/5/20
11/15/20
11/25/20
Stream EC-µS/cm
Stream Temp C



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 Boise State University in 2020. Additionally, the amount of data from field measurements in 2021 is extremely limited and would require more values to determine a pattern.

Conclusion:

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.

Bibliography/Citations:

Bartley, R., Speirs, W. J., Ellis, T. W., & Waters, D. K. (2012). A review of sediment and nutrient concentration data from Australia for use in catchment water quality models. *Marine Pollution Bulletin*, *65*(4–9), 101–116. https://doi.org/10.1016/j.marpolbul.2011.08.009

Boise State University, Department of Geoscience (2021). *Dry Creek Experimental Watershed*. **https://www.boisestate.edu/drycreek/watershed-desciption/**

Boise State University, Department of Geoscience (n.d). *Dry Creek Experimental Watershed*. **https://www.boisestate.edu/drycreek/watershed-desciption/**

Brooks, K.N., Ffolliott, P.F., Magner, J.A. 2013. *Hydrology and the management of watersheds, 4th Ed*. Wiley-Blackwell Publishing. ISBN-13:978-0-4709-6305-0

Thomas, A.G. (1986). Specific conductance as an indicator of total dissolved solids in cold, dilute waters, Hydrological Sciences Journal, 31:1, 81-92, DOI: 10.1080/02626668609491029

Schuler, M. S., & Relyea, R. A. (2018). A Review of the Combined Threats of Road Salts and Heavy Metals to Freshwater Systems. *BioScience*, *68*(5), 327–335. https://doi-org.uaf.idm.oclc.org/10.1093/biosci/biy018

Szlarek S., Gorecka A., Wojital-Frankiewicz A. (2022). The effects of road salt on freshwater ecosystems and soultions for mitigating chloride pollution, A review. *Science of The Total Environment*, 805. https://doi.org/10.1016/j.scitotenv.2021.150289