NM WRRI Student Research Grant Final Report

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Faculty Advisor: Jennifer Lindline, Ph.D.

Title of Project: Water Quality Monitoring and Assessment of the Mora River at the Rio Mora National Wildlife Refuge, Mora County, NM.

Problem Statement and Objectives: The Rio Mora National Wildlife Refuge encompasses approximately 4600 acres of land within the National Wildlife Refuge System. The Mora River flows through the property for roughly 8 kilometers within a narrow, approximately 100-meter canyon. The major management priorities of the Refuge are to reestablish the vegetation along the Mora River and enhance preservation and conservation of endangered aquatic organisms and plants. For the survival of endangered species, the biological, chemical and physical attributes of the river must be adequate. This study established baseline levels and trends in stream flow and water quality of the Mora River as the water quality in the system sets the basis for the rest of ecosystem health.

Stream flows within the Mora River are variable and highly dependent on spring runoff and summer monsoonal rains. Stream flow is responsible for many of the physical characteristics of the stream as well as the biological aspects, since aquatic plants and animals depend upon steam flow to bring vital food and nutrients from upstream, or to remove waste downstream. Higher flow is important for dilution of pollutants; many river and streams that violate water quality standards for common pollutants do so when flows are abnormally low. Knowing if and how water quality is changing in seasonal and longer-term climate change is imperative, as the quality of water in a system sets the basis for the rest of the ecosystem health. This study set out to collect, analyze, and interpret Mora River stream flow and water quality data for a five-year period (2014-2018). The data and interpretations of this study will be shared with the Rio Mora Conservation Science Center to inform land management decisions.

Methods

Stream flow data for the Mora River just upstream (~5 km) from the Rio Mora National Wildlife Refuge at the town of Golondrinas are available from the U.S. Geological Survey gauging station 07216500. Streamflow data from water years 2015 through 2019 water years were downloaded, averaged, and assessed to capture the effects of water recharge to, discharge from, and flux through the system.

The physical-chemical water quality attributes that were assessed included: temperature, dissolved oxygen specific conductance, pH, and turbidity. These parameters were collected in the field using a YSI 6920 V2 Multiparameter Water Quality Sonde, a monitoring station that was established at the Rio Mora National Wildlife Refuge in 2014. The instrument takes water parameter measurements every 15-minutes of every day. The Sonde is transported to the laboratory every 40 days for data download and recalibration. A portable turbidimeter was also being used for additional turbidity measurements, as local streams have been found to be impaired for turbidity.

For concise data analysis, data from the water quality sonde were exported into several spreadsheets. Microsoft excel 2016 was used because it provided enormous versatility, automation in data management, visualization, and analysis. The measured physicochemical parameters were processed and presented as mean, median, standard deviation, minimum and maximum values on a biweekly basis.

With the objective of establishing and exploring correlations between stream flow and all measured physicochemical parameters, Microsoft excel 2016 was used to calculate Pearson's product moment correlation coefficient (r). Microsoft excel 2016 was also used in performing a one-way ANOVA (Analysis of Variance) to determine the significant difference between year-to-year water quality variable data. Correlation of significance was also tested using P-value testing and in all contrasts a P-value less than 0.05 means that there is significance difference between the mean values while non-significant difference exists between the mean if the P-value is greater than 0.05.

Results

The results of physicochemical parameters measured throughout the study period (2015-2018) are presented below. Points or intervals with no data represent breaks in data collection from the YSI Sonde due to memory overload, loss of power, and/or damage to the sensors.

Qualitative results demonstrated that water quality physical parameters showed annual variations that were strongly correlated with stream flow variations. The measured physico-chemical parameters fell within the established ranges that support designated marginal cold-water use of the middle Mora River.

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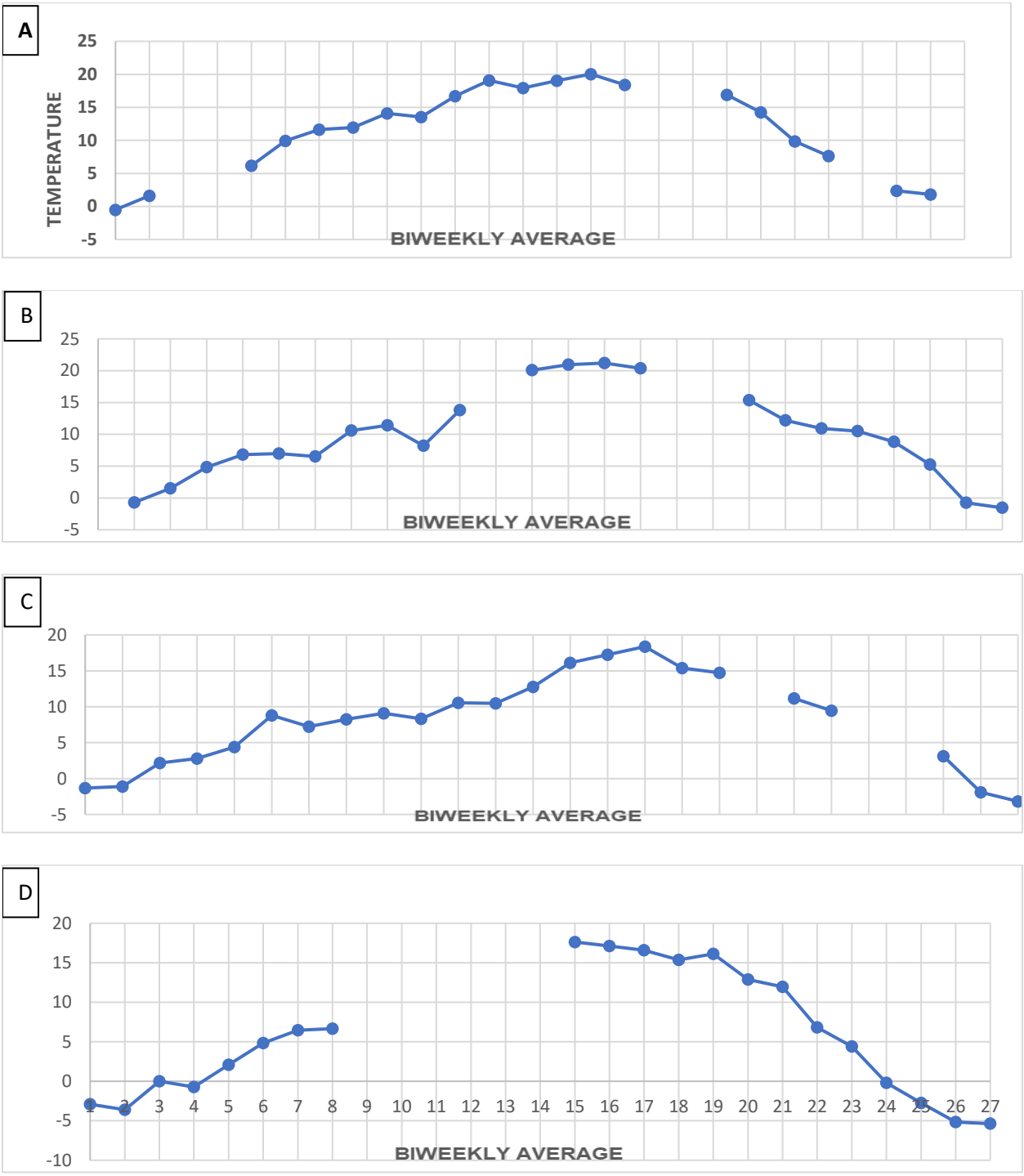


Figure 1: Biweekly water temperature averages for the Mora River at the Rio Mora National Wildlife Refuge monitoring station for the years 2015, 2016, 2017, and 2018. Values on the x-axis correspond to biweekly calendar weeks (i.e. 1 = January 1 and 27 = December 15).

DISSOLVED OXYGEN

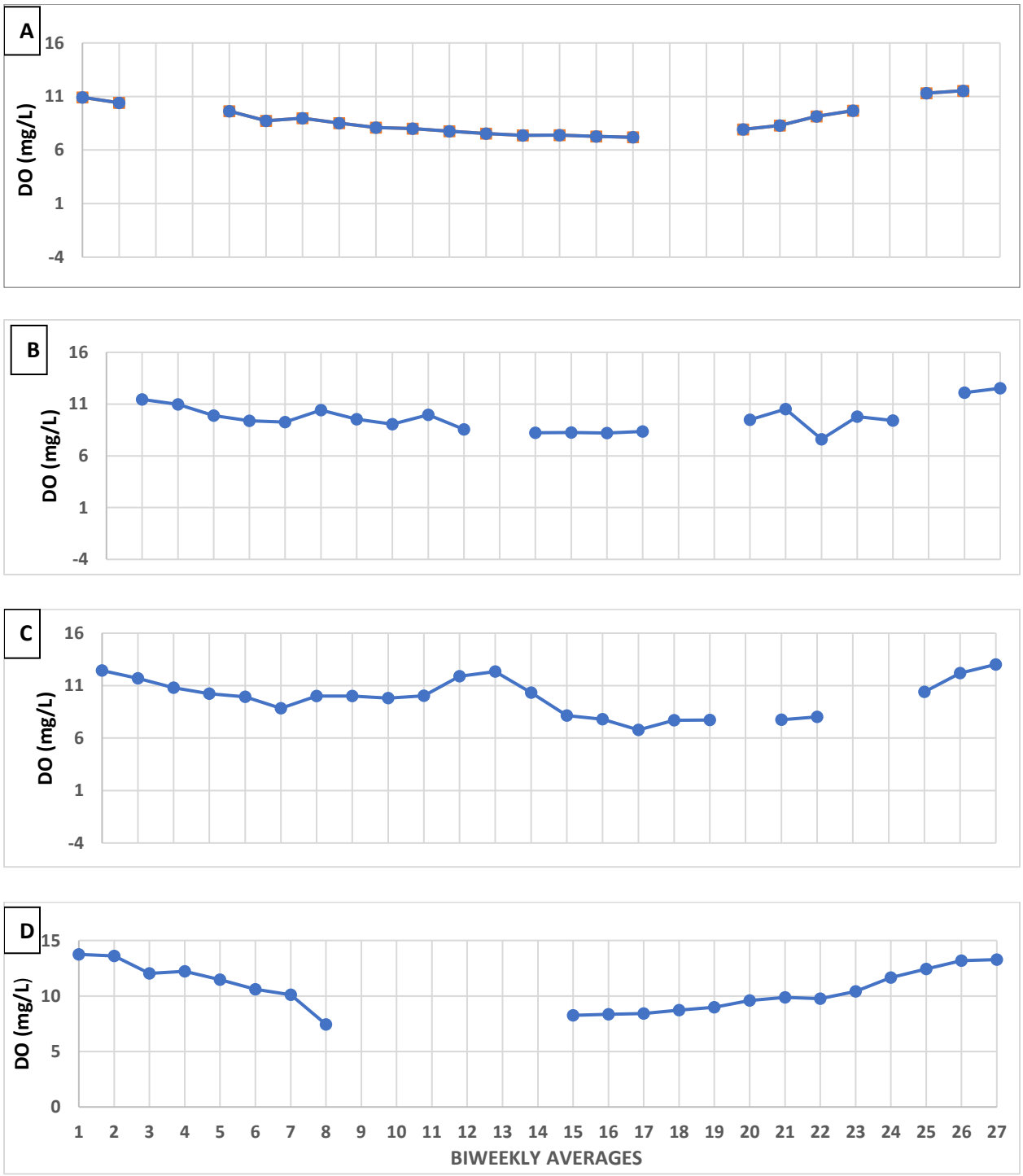
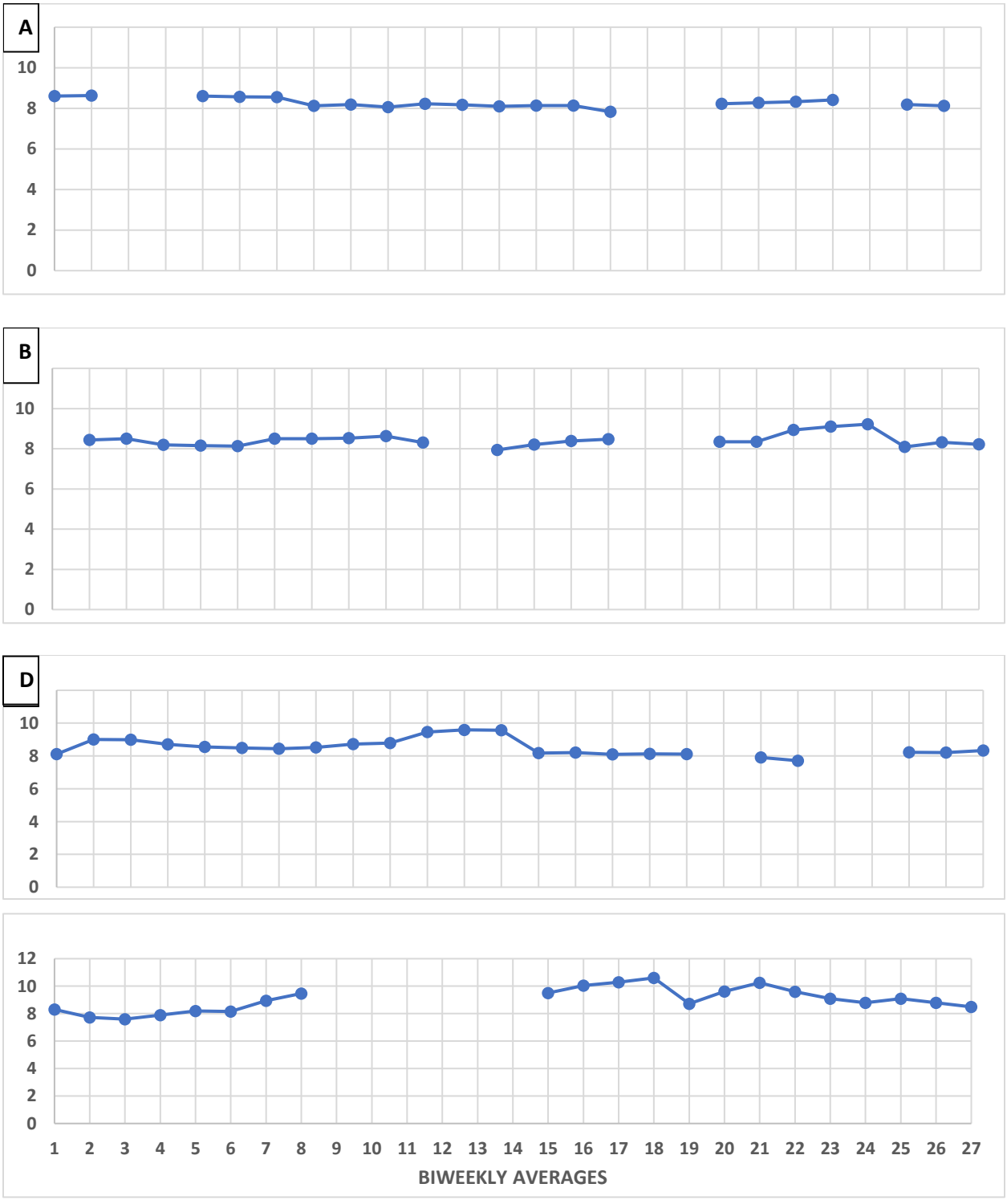


Figure 4: Biweekly dissolved oxygen averages for the Mora River at the Rio Mora National Wildlife Refuge monitoring station for the years 2015, 2016, 2017, and 2018. Values on the x-axis correspond to biweekly calendar weeks (i.e. 1 = January 1 and 27 = December 15).

WATER PH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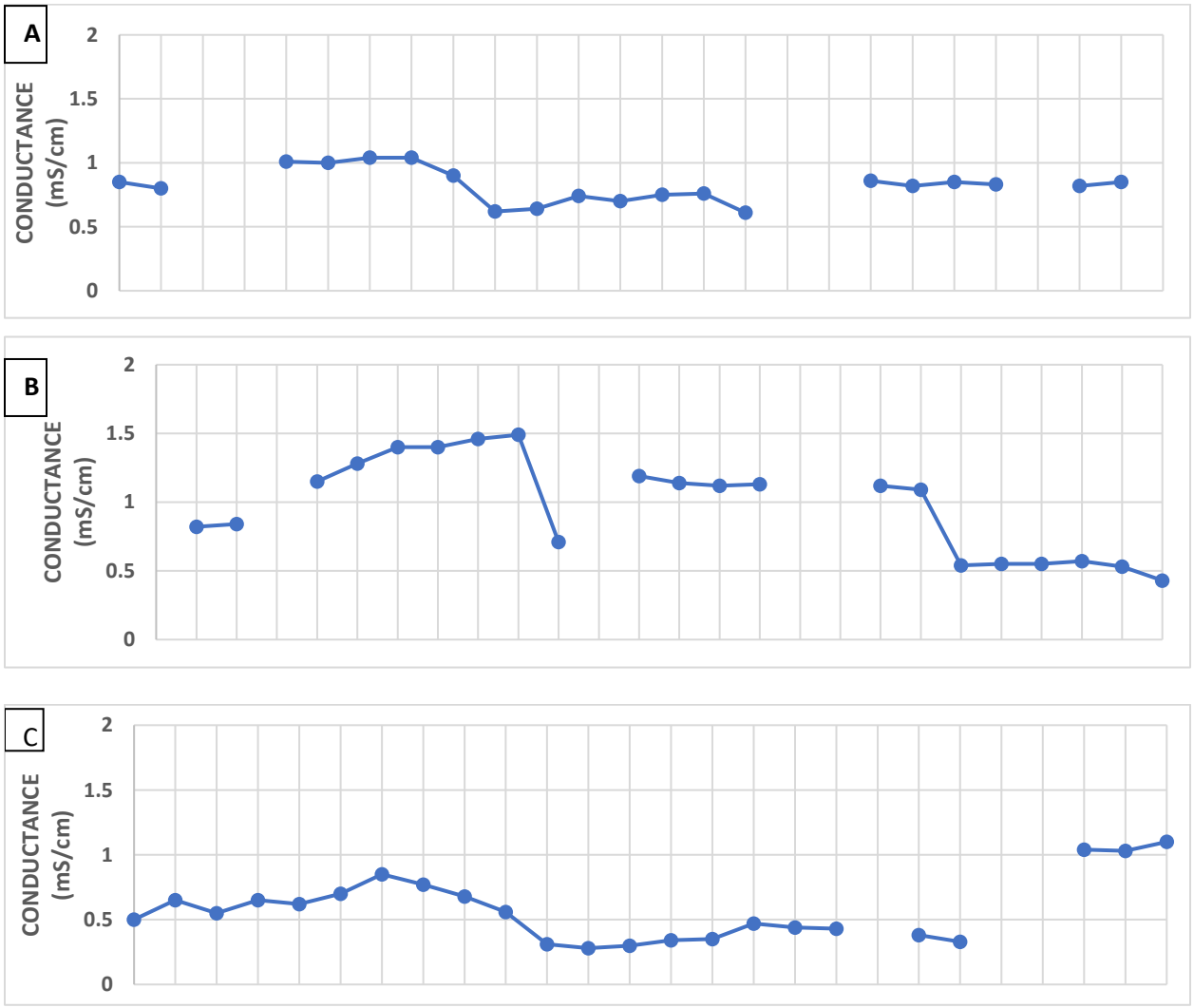
BIWEEKLY AVERAGES

Figure 5: Biweekly water pH averages for the Mora River at the Rio Mora National Wildlife Refuge for the years 2015, 2016, 2017, and 2018. Values on the x-axis correspond to biweekly calendar weeks (i.e. 1 = January 1 and 27 = December 15).

CONDUCTIVITY



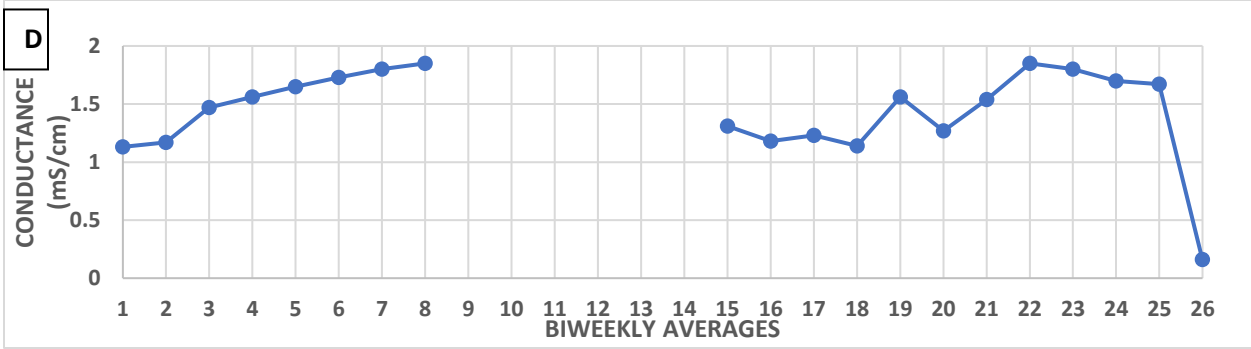


Figure 6: Biweekly conductivity averages for the Mora River at the Rio Mora National Wildlife Refuge monitoring station for the years 2015, 2016, 2017, and 2108. Values on the x-axis correspond to biweekly calendar weeks (i.e. 1 = January 1 and 27 = December 15).

TURBIDITY

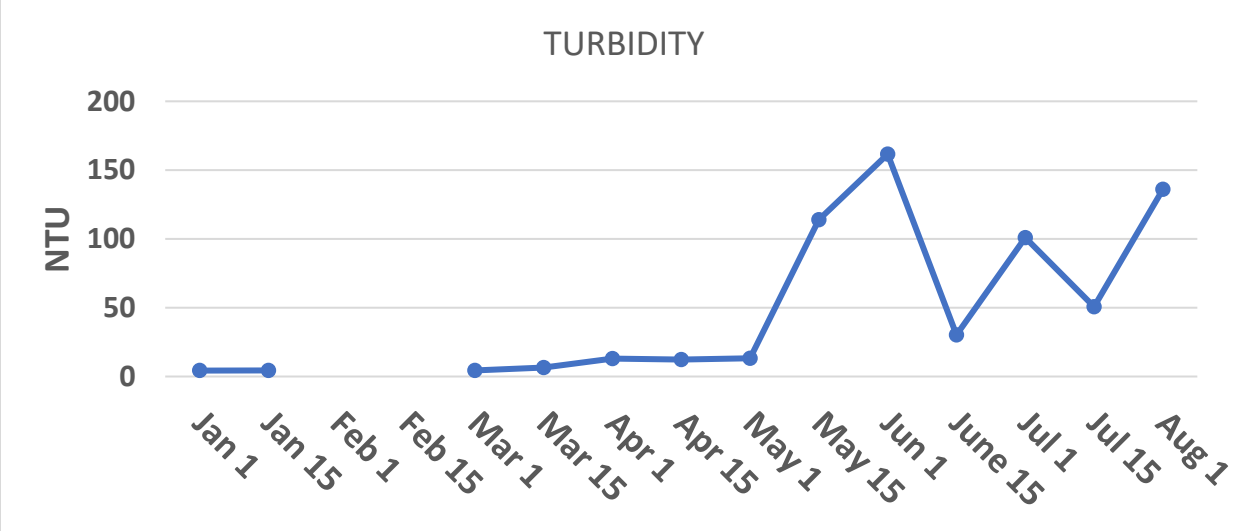


Figure 7: Turbidity averages for the Mora River from the Rio Mora National Wildlife Refuge monitoring station for the period of January-August 2015.

Conclusion: This study indicated that variation in streamflow (driven by climate variability) is the major causal factor influencing water quality in the Mora River at the Rio Mora National Wildlife Refuge. As quantified by the statistical and correlational analysis, the water quality at the Refuge between 2015 and 2017 remained within the Total Maximum Daily Load prescribed by the U.S.

Environmental Protection Agency (USEPA) and New Mexico Environment Department (NMED) for marginal cold-water use. However, a substantial drop in water quality was observed in 2018 notably in water pH and conductivity. This dip is attributed to the fact that streamflow in 2018 was low compared to other study years. The impact of streamflow on water quality suggests that the Mora River is highly vulnerable to climate variability and its concomitant influence on stream flow variability, hence the need to ensure that sustainable water and land management use is encouraged at the Rio Mora National Wildlife Refuge.

In order to ease the anticipated effect of streamflow variation on water quality at the Mora River, building structures that capture water and hold moisture in sediments should be encouraged. For example, planting cover crops and deep-rooted plants, which increase the ability of the soil to absorb heavy rainfall and release them during dry season. Maintaining and increasing canopy along the rivers banks is another approach to reduce the effect of climate variability. This approach helps in shading and cooling the water for the benefit of aquatic species during high temperature years.

This study is important because the projected warming trends have the potential to cause a later transition from rain to snow in the mountains, higher snow line, less total snowpack, earlier snowmelt in springtime, and increased evapotranspiration rates in the warm season. As this study demonstrated, lower stream flow negatively impacts water quality. Therefore, the Mora River's ability to preserve and conserve endangered aquatic organisms and plants hangs in the balance.

Who will benefit from this research?

The Rio Mora National Wildlife Refuge and the Denver zoo are the major agency that will benefit from the results of this research.

How have you spent your grant funds?

So far, 100% of the grant's funds have been encumbered or expended. The student researcher spent monies on regular travel to the field site as well as monies for the November 2019 New Mexico Water Resources Research Institute conference. Funds were also encumbered for the water analysis, including commercial analysis of water samples and in-house purchase of a portable turbidimeter.

Presentations made related to this research

A presentation was made at the last Geological Society of America (GSA) annual meeting in Arizona on September 22nd, 2019. A thesis presentation was also conducted at New Mexico Highlands University on December 13th, 2019.

Publications or reports been prepared

No publications or reports are been prepared at the moment.

List any other students or faculty members who have assisted you with your project

Dr. Edward Martinez (Professor at New Mexico Highlands University), Daryl Williams (Equipment Manager at New Mexico Highlands University), and Jordan Martinez (Graduate Student at New Mexico Highlands University).

Special recognition awards or notable achievements

As a result of this research, I received a certificate of achievement from the Office of the Attorney General of the State of New Mexico.

Degree completion and future career plan

After my anticipated graduation date in May 2020, I intend to apply to a water management related Ph.D. program.