P1.2 A SPATIOTEMPORAL INVESTIGATION OF THE INFLUENCES OF WEATHER ON THE HYDROLOGICAL CHARACTERISTICS OF A MONTANE MELT WATER ENVIRONMENT

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1. INTRODUCTION

During the summer of 2002, 25 high school students from the United States and Scotland conducted a three week field study of the Oliver Creek catchment basin in the Cloud Peak Wilderness Area, located in the Big Horn Mountains of northern Wyoming. The Cloud Peak site was not the primary area of study, but given the fact that grizzly bears were discovered at the planned site in Montana, the expedition was relocated to the Big Horn Mountains. The field study, conducted from July 3 to July 19, integrated various facets of the valley's ecology including vegetation, meteorology, energy budget, geologic mapping, chemistry of the streams and lakes, and biology. Similar studies were conducted at this site in the summers of 1998 and 2000. Observations indicated significant changes since the studies in 1998. This paper focuses on some of these changes; specifically, a comparison of pH, stream flow, and weather patterns.

2. RATIONALE

Studies done in the years 1998, 2000, and 2002 followed dramatically different winter and spring climactic patterns, provoking questions as to the influence of the meteorological and hydrological components on the rest of the ecosystem.

The Oliver Creek Basin is drained by a single stream fed by melt water whose level is dependent on the water content of the winter and spring precipitation. Climate data for these years indicated a significant change in the available water as reported by a nearby Snotel station. A comparison of three field studies seeks to investigate correlations between the winter precipitation patterns on the chemical and physical characteristics of Oliver Creek. Although each of the field studies only spanned a similar three week period in late June to mid July, the authors seek to observe the influence on stream characteristics of the current drought patterns in the western US as compared to periods experiencing more normal precipitation patterns.

See Appendix 1.

3. SITE DESCRIPTION

The Cloud Peak Wilderness Area, part of the Bighorn National Forest, is a 189,000 acre region of mountainous terrain shaped in part by prehistoric glacial activity. The max elevation of the cirque complex is 10,500 feet. Our studies, conducted in the cirque valley at elevations ranging from 8500-9200 feet, were primarily concentrated along Oliver Creek, the melt water stream that flows alone through the cirque valley.

4. MEASURMENT SITES

Three sites were chosen for the placement of meteorological stations: a National Oceanic and Atmospheric Administration (NOAA) station erected on a peninsula jutting into Ringbone Lake, a Davis VantagePro station on the southeast bank of Long Lake, and another Davis station at a meander in the lower section of Oliver Creek. This second Davis station (Figure. 1) was accompanied by a gauging station consisting of similar equipment as was deployed in 1998 and 2000 (a flow meter, a recording pH meter, and a water temperature sensor).

Figure 1: Davis station at meander.

5. INSTRUMENTATION

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Water level in the stream was recorded using a Stevens' Chart Drive FW-1 Water Level recorder (Figure. 2). This meter was placed atop team designed PVC pipe stands at a meander in the flood plane.

Figure 2: Recording flow meter.

The employed pH meters (Figure. 3), self-recording Analytical Measurements model 30WP, were set up to monitor diurnal cycles in the stream. Water temperature was recorded using submersible temperature probes from the Davis instrument and transmitted electronically to the adjacent meteorological station. The NOAA station provided the instrumentation necessary to compute incoming solar radiation.

Figure 3: pH Meter

Most of the weather data for this study was gathered using Davis VantagePro Plus. Data was collected continuously every half-hour. The instruments were located at positions similar to the stations deployed in 1998 and 2000. These locations were on the southeast side of Long Lake and in the wetlands one kilometer downstream. A wireless integrated sensor suite running on solar power included the ability to directly determine the parameters for meteorological and stream measurements. In addition, employing the new technology associated with the Vantage Pro Plus 6160 weather station enabled the use of wireless stainless steel temperature probes for obtaining a continuous record of stream and soil temperatures. All meteorological data was viewed using Weatherlink 5.0 beta software installed on two laptops operating Windows.

6. FIELD METHODS

The pH meter and flow meter were set up for continual monitoring of Oliver Creek's pH and water depth. Data collection ran smoothly with the exception of a three day gap, resulting from the absence of desiccator plates during a period of heavy precipitation. The Davis Station archives were recorded in thirty-minute intervals and stored on a data logger. The data was then downloaded to a laptop computer every other day.

7. ANALYSIS

Though the appearance of the stream remained similar to the observations of previous years, this study has observed extreme differences in stream characteristics between 1998, 2000, and 2002 expeditions.

An organized attempt was made to determine the general properties of the stream and assess them with respect to the data collected in the previous expeditions. Data was collected at the same location along the stream in all three studies.

The 1998 study observed a large influx volume of fresh water into the Oliver Creek basin noted by Snotel data for that year. Summer heat in the area melts the ice, thus releasing extra volumes of water into the basin. The added water, at the melting point temperature, had a cooling effect on the stream. Snotel data for 2000 illustrated a decreasing amount of precipitate and snow water equivalent in the region. The Snotel data for 2002 indicated an even more significant depletion of the water.

To determine exactly how the variables in climate contributed to the observed changes in stream temperature, pH (Figure 4), and flow (Figure 5) a comparison of the three studies is being investigated. The results are expected to be available at the annual AMS conference.

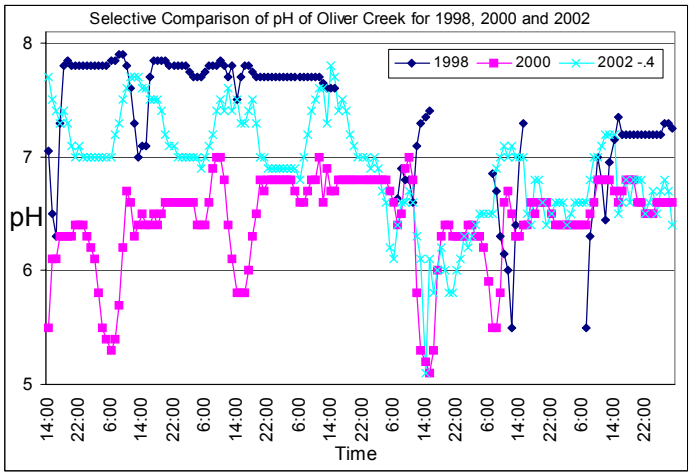

Figure 4: Comparisons of Stream pH

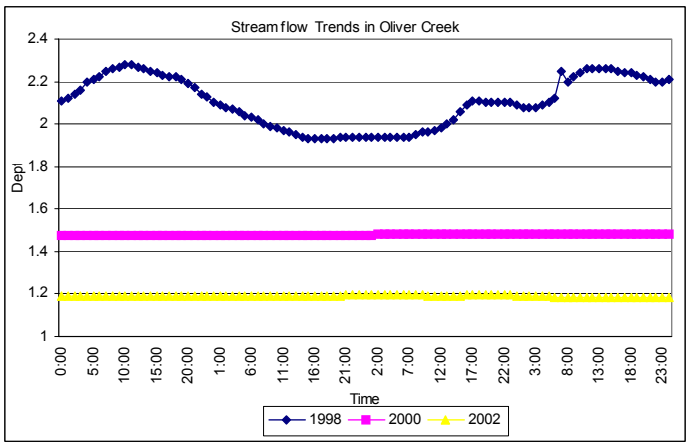

Figure 5: Comparison of Stream Flow

8. SUMMARY

The 2002 expedition builds upon the expeditions of 1998 and 2000, following the recommendations of those teams. During the summer of 2002, significant differences in the hydrology of the valley were observed. The major differences involved stream flow and temperature and pH. Given this to be a simple melt water complex, the meteorological parameters during the study period are also being analyzed to determine their influence on the observed changes in stream hydrology.

9. ACKNOWLEDMENTS

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Appendix 1:

Light Green – average accumulated moisture for life of station; Dark Green – total precipitation to date; Light Blue – Average snow-water equivalent for life of station; Dark Blue – year to date snow-water equivalent.