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Effects of increasing average air temperature on thermal gradient of streams

2012 CLIMATE CHANGE RESEARCH PROPOSAL

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"Effects of increasing average air temperature on thermal gradient of streams: (stream name)"

Project Description

There are many ways in which a stream can be degraded – pollution discharge, dewatering, channelization, damming, etc. But climate change can alter a stream's productivity and diversity in less obvious and harder to quantify ways than these more obvious forms of degradation. Temperature is a vital environmental factor for organisms living in streams. Understanding how river/stream ecosystems respond to a warming climate is important for the conservation of Montana's streams, rivers, and lakes. The project I propose will involve the collaboration of one to three students collecting temperature and physical data on one or two tributaries of the Clark Fork River (number of streams is dependant on the number of students involved). The temperature and physical data will be used in conjunction with SSTEMP, a computer program that models temperature change in sections of a stream based on specific parameters (available through USGS). To measure air & stream temperatures, data loggers will be placed along and in different reaches of the stream(s) in June, once stream flows drop to safe levels and landowner/land manager permission is obtained. Reaches will represent a variety of characteristics (i.e. a reach with dense vegetation and one without) in order to make meaningful comparisons between reaches where conditions are likely to result in a very different heat budget. The data from the temperature loggers will be collected weekly or bi-weekly until August. Also in early June, physical characteristics needed for SSTEMP will be determined, including stream flow, geometry, vegetation/shade, topographical relief on the banks. Using various subsets of these data, SSTEMP will be calibrated and validated for our streams. Then SSTEMP will be run for several scenarios (current conditions, reference conditions) to determine if the stream(s) should be considered thermally impaired and also to create a baseline we can use to assess how climate change impacts these streams in the future. In addition, parameters within the SSTEMP model can be manipulated to determine how changing conditions (increased air temperature, lower flow) can change the stream's temperature. This will help highlight what is needed to restore an impaired stream and can also determine how human induced alterations can impair a healthy stream (flow diversion, climate change, etc.). Streams impacted by other stresses may be at greater risk from climate change than those that are less impacted.

Purpose

The purpose of this project is to provide the necessary data and information to assess if streams have an elevated risk of thermal degradation. Understanding stream heat budgets and how air temperature, stream flow, and shading increase or decrease a stream's temperature is at the core of prioritizing streams at risk for thermal impairment. Knowing how these different factors can make a stream more susceptible to climate change can also guide the management and restoration of impaired streams. Many streams in Montana are already impaired by higher temperatures, putting aquatic organisms in danger as there are fewer areas that provide temperatures cold enough for spawning. This project addresses the state's need to mitigate the effects of increasing average global temperatures by understanding natural controls on a stream's thermal gradient. We need to conserve Montana's aquatic habitat and organisms for present and future generations. In order to effectively accomplish this task, it is important to understand what conditions can impair these bodies of water, including climate change.

Methods

- Collaborate with local fisheries biologists to select best stream(s) for research.
    - Streams that are important tributaries of the Clark Fork and that have a variety of land uses along their length, or a variation in stream health between reaches, or are important aquatic habitats. Streams with historical temperature data are especially desirable.
- Determine reaches to be studied based on their physical characteristics.
- Use water proof temperature data loggers to collect a summer's worth of water temperature for various reaches.
- Measure other physical characteristics of the reaches needed for SSTEMP program, including:
    - Flow – continuously monitor flow as it changes over the summer – using a staff gauge & gauge height rating curve (developed by relating flow to gauge height at several key points from low to high flow).
    - Riparian vegetation – shading density (as a % of solar radiation, using a densitometer to observe amount of sunlight penetration, spacing of vegetation, and height of vegetation).
    - Topography – if there is significant topography on the banks of the stream, the height will need to be calculated.
    - Climatic data – regional air temperature to supplement our measurements.
    - Location ––longitude and latitude (using a GPS), so that SSTEMP can determine the amount of solar radiation available over the summer.
- Use collected data and SSTEMP to study the heat budget of the stream segments.
- Manipulate various parameters in SSTEMP, such as increasing/decreasing flow, air temperature, density of riparian vegetation, etc. to determine how altering the different features of the stream can thermally degrade or restore it.
- Make conclusions.

From conducting this research project I hope to provide strong evidence for classifying a tributary of the Clark Fork as thermally healthy or impaired. By accomplishing this it will also develop a baseline for evaluating the future condition of the stream. Also, I hope to acquire a thorough understanding of how hydrology, riparian, and morphology of a stream contribute to its susceptibility to thermal impairment. And to understand how human alterations of these features can change the thermal behavior of the stream and thus affect the ecosystem as a whole (aquatic habitat, organisms, and inhabitability). This can inform climate change mitigation decisions and land management practices in the face of a warming climate.