Project Summary
Rocky Mountains Cooperative Ecosystem Studies Unit

Project Title: Comparing Stream Invertebrate Assemblages Before and After Wildfire in Yellowstone

Discipline: Natural Resources
Type of Project: Research
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Other Partners/Cooperators: University of Wyoming
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Investigators and Agency Representative:
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Project Abstract: Warmer, dryer climatic conditions during the past 30 years have been attributed to increases in severe, stand-replacing fires in the western US (Westerling et al. 2006). Yellowstone National Park has experienced numerous large, severe fires, beginning with the large fires of 1988 and including several recent years during which thousands of hectares of forest have burned. These stand-replacing fires essentially remove the forest canopy and initiate new successional trajectories that persist for decades (Turner et al. 2003). In addition, a shift in dominant species, along with the creation of abundant bare mineral soil can often increase the inputs of important nutrients such as nitrogen into adjacent streams and lakes (e.g., Gresswell 1999), similar to Likens et al. (1970) who discovered large pulses of nutrients exported from watersheds after clear-cutting a forest. Turner et al. (2007) studied terrestrial N cycling in Yellowstone and Teton National Parks after fire and noted that N uptake switch from microbes to plants as succession proceeded. Turner et al. (2007) and climate predictions have prompted us to further investigate how fire will alter aquatic processes in recipient streams.

Streams food webs may change after wildfire due to altered light levels, nutrient concentrations, and hydrology. Forest canopies open after wildfire increasing light levels that reach streams. Higher light levels along with higher nutrient concentrations increase primary production (e.g., algae) in streams (Mihuc 2004). Higher primary production may cause bottom up effects in streams and subsequently change the aquatic invertebrates and fish in these ecosystems. However, changes in hydrology may limit algal, invertebrate, and fish growth (Minshall et al. 2001a). Water levels can change rapidly in burned watersheds, because of the lack of terrestrial vegetation as a buffer. Thus, floods can scour streams in burned watersheds removing algae and invertebrates.

Bottom up effects and hydrology may change the energy flux to higher trophic levels, but little is known about the effects of fire on aquatic food webs (Minshall 2003). If bottom up effects predominate, secondary production may increase after wildfire because of increased food resources. Secondary production is the accumulation of invertebrate biomass over time, and is the best measure of the success of an assemblage because production takes growth, reproduction, mortality, and survival into account. However, floods may reduce secondary production of invertebrates by removing both algae and invertebrates themselves. Previous studies have not measured the energy flux through aquatic invertebrates before and after fire. However, Perry et al. (2003) discovered that wildfire limited the invertebrates available to juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in streams in Yukon Territory, Canada.

To investigate the effects of wildfire on streams, we collected aquatic invertebrates from Cub and Little Cub Creeks on the east side of Yellowstone Lake before and after the East Fire (Figure 1). Many studies of wildfire compare a burned stream with a reference stream (Minshall et al. 2001b), because collecting samples prior to a fire is primarily by chance. Thus, having samples before and after fire will improve our knowledge of the effects of wildfire on stream invertebrates. The timing of our study was serendipitous with the fire burning after our first year of collecting samples. Therefore, we collected one year of data prior to the wildfire (2003) and 2 years of data after the fire (2004 and 2005). Therefore, our study design is ideal to estimate the effects of wildfire on stream invertebrates. The East Fire was a crown fire that set ablaze >17,000 acres and burned 95% of the watersheds of each of these streams. Invertebrate samples have been sorted and preserved, but have not been analyzed because of lack of funding. We propose to analyze the samples in this unique dataset to understand how wildfire can alter stream invertebrates. Working in Yellowstone National Park is opportune, because few other perturbations exist and the effects of wildfire can be easily studied.

Our specific objectives are to examine:
1.) What affect did wildfire have on the density and biomass of aquatic invertebrates?
2.) How did the composition of aquatic invertebrates change before and after wildfire?
3.) How did secondary production of aquatic invertebrates change before and after wildfire?
4.) To what degree does lake primary productivity vary among sites?
Results from our study will inform managers about how the food base for fish (i.e., aquatic invertebrates) changes after wildfire.

Outcomes with Completion Dates: December 31, 2011

Keywords: aquatic invertebrates, wildfire, Yellowstone National Park, University of Wyoming