A Multi-trophic Level Investigation Sheds Light on Long Term Responses of Stream Ecosystems to Wildfire

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Rationale

Decades after wildfire, stream ecosystem state may reflect the severity of fire and the recovery of riparian vegetation, which may strongly influence light availability and, in turn, the productivity patterns of stream organisms. Few studies have investigated such longer-term effects of wildfire, and we are aware of none that have made direct measurements of organism production.

Study Design

In a wilderness watershed of central Idaho, we studied three streams of similar size that experienced past wildfire (yrs. 2000 & 2005) but now range from low to high light conditions. During summer, we compared these streams in terms of aquatic primary production, secondary production of invertebrates and fishes, and the trophic basis of fish production.

Methods

Gross Primary Production

Gross primary production (GPP) and community respiration (CR) were measured via the chamber technique.[1] During early, mid, and late summer, rocks were collected and placed in metabolism microcosms. These were submerged in-stream where ambient temperatures and light conditions were maintained. Oxygen dynamics were monitored for 2-hr incubations in light and dark conditions.

Results & Methods

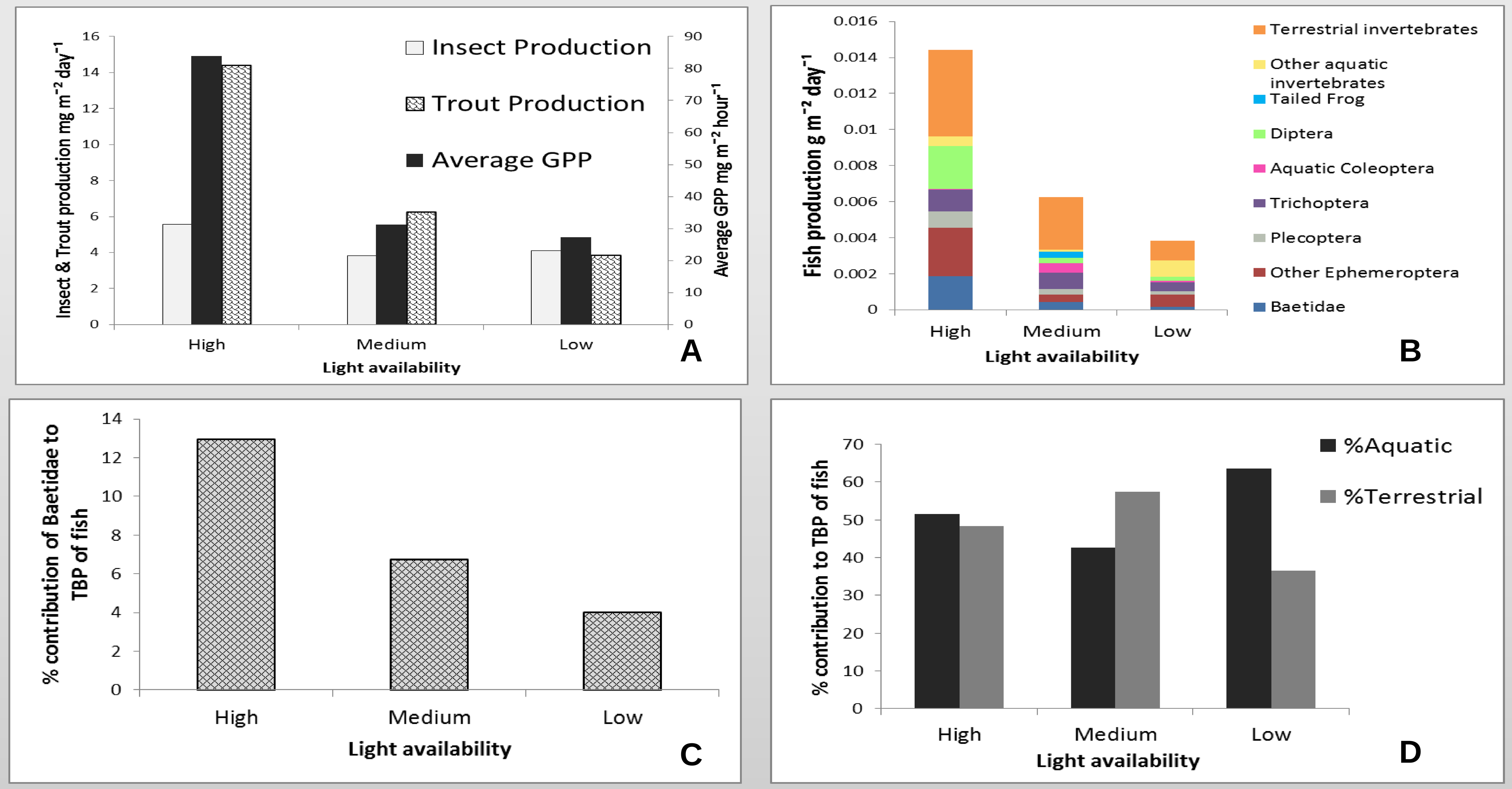
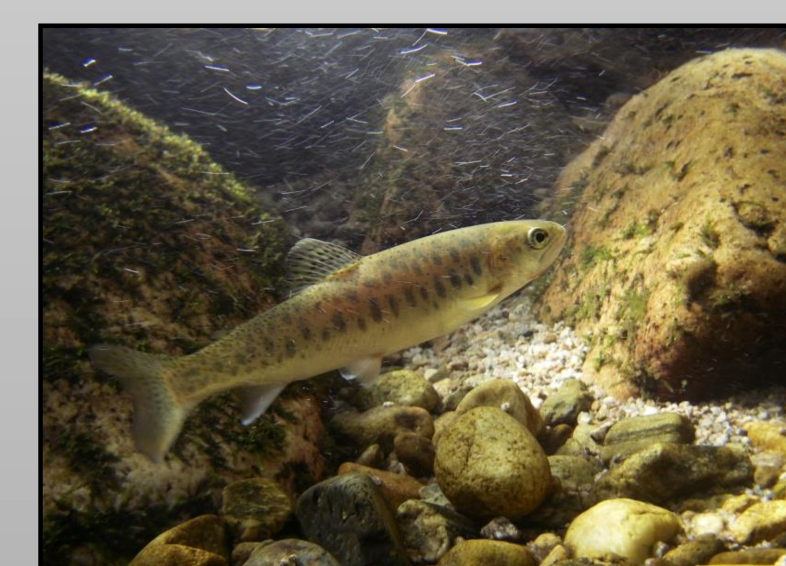


Figure **A.** Light availability versus aquatic gross primary production, production of insects Baetidae and Chironomidae, and fish production. Figure **B.** Trophic basis of fish production. Figure **C.** Light availability versus the relative contribution of Baetidae to the trophic basis of fish production. Figure **D.** Proportion of fish production attributable to aquatic versus terrestrial prey.

Aquatic Insect Production

Production was measured for Baetidae and Chironomidae, which dominate numbers and biomass of the benthos in these streams. Samples (3 per stream per period) were collected bi-weekly June-August using a Surber net. Insects were counted and measured in the lab. Length-weight regressions were used to estimate biomass, and we used the increment summation method[2] (a non-cohort approach) to calculate production.

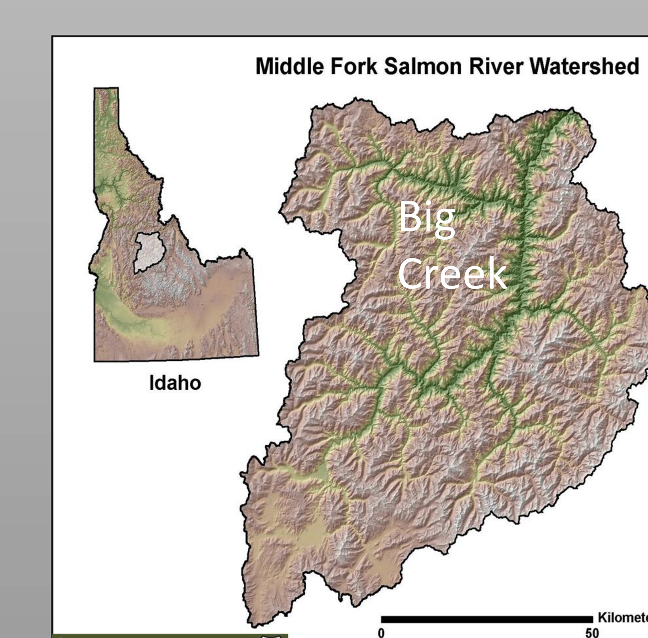


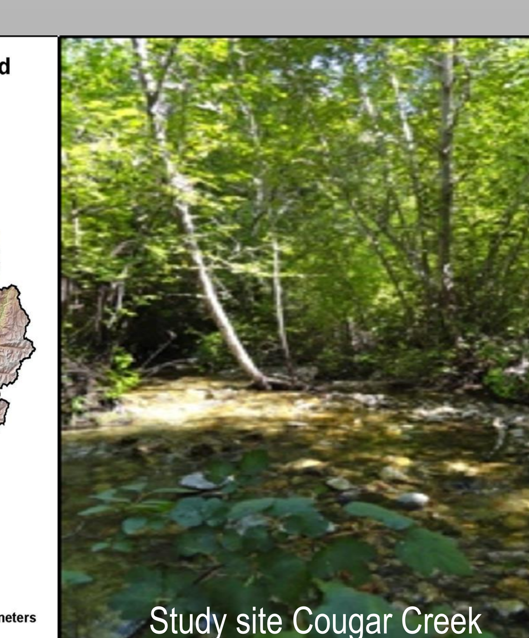
Fish Production and What Fuels It

Trout production was measured by instantaneous growth rate method[3], using combination of nocturnal underwater surveys in early, mid and late summer and measurements of fish captured via hand netting. Fish were identified, lengths estimated, and size and abundance estimates used to calculate fish biomass and instantaneous growth rates for each stream and period. Gut contents (via non-lethal gastric lavage) and assimilation efficiencies from literature were used to calculate the trophic basis of fish production (TBP).[4]

Results & Discussion

- Patterns in productivity were generally mirrored across trophic levels, such that streams with greater light availability had higher production rates.
- Among streams, aquatic GPP was 3X greater in the high versus low light stream, with the third falling intermediate.
- Production of the dominant insect taxa, Baetidae and Chironomidae, was 41% higher in the high light stream versus either of the two low light streams. Trout production was 3.8X greater in the high versus low light stream.
- The trophic basis of trout production was most diverse in the stream with intermediate light, which also had the greatest proportion of terrestrial insect contribution to TBP of trout.
- Our findings suggest light regime may mediate post-fire pulses in stream productivity across three trophic levels, as well as changes in the diversity and complexity of food webs.





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