Spatial Complexity of River Network Promotes Biodiversity

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Rationale

Habitat heterogeneity has long been thought to be important to the maintenance of biodiversity at both local and global scales. In stream environments, unique "niche" habitats provide refuge for a myriad of specialist species whereas habitat homogenization is generally conducive to habitation by a very limited variety of species. Homogenization of habitats, due to anthropogenic influence, is increasingly common and the urgency to better understand the importance of spatial habitat complexity has become increasingly significant. The aim of this study was to provide better insight as to what factors contribute most to the maintenance of biodiversity among stream invertebrate communities.

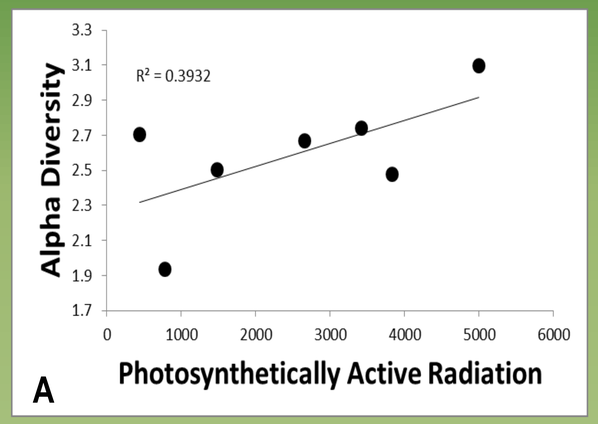
Hypothesis

- **H1:** Light availability and stream size indirectly mediate macroinvertebrate diversity.
- **H2:** Watersheds consisting of diverse habitats harbor more diverse macroinvertebrate communities than river networks consisting of relatively homogenous habitats.

Study Design

In a central Idaho wilderness watershed, a survey of benthic invertebrate communities was accomplished for seven streams with varying habitat characteristics. Here, alpha diversity was calculated and compared to stream size and light availability to determine if potential relationships exist. In a second analysis, an experimental approach was taken to create a hypothetical river network in which riverscape (gamma) diversity may be maximized through combination of certain stream habitat types.

Results



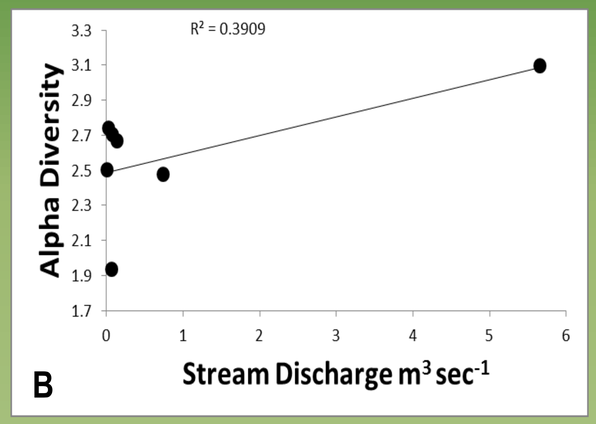
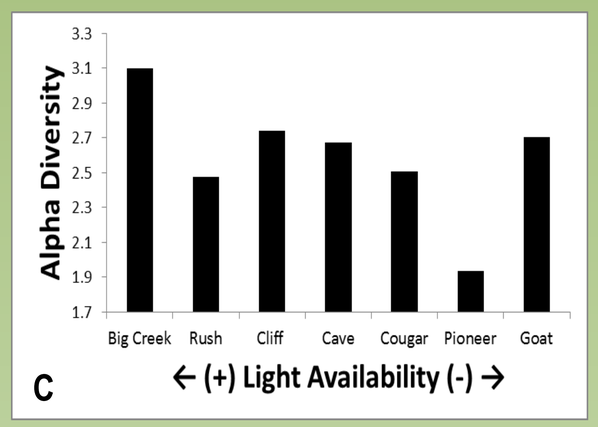


Figure A. alpha diversity versus photosynthetically active radiation (PAR)
Figure B. alpha diversity versus stream discharge



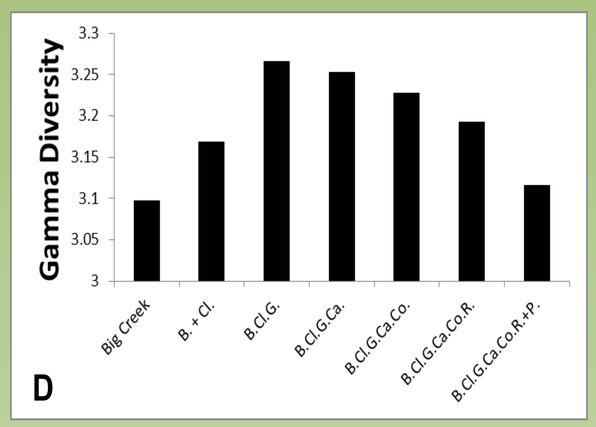
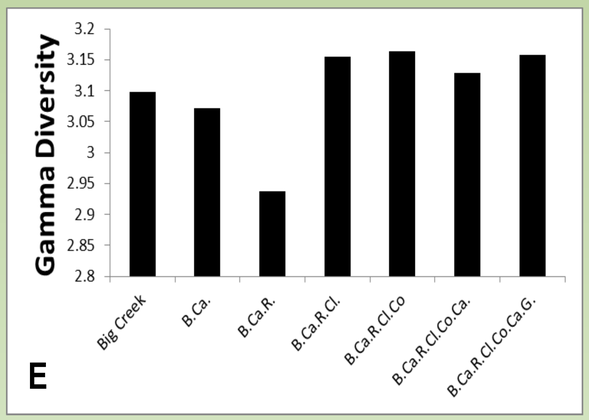


Figure C. alpha diversity versus streams ranked from highest to lowest light availability
Figure D. gamma diversity of 7 hypothetical stream networks in which streams were added to Big Creek main-stem in order of alpha diversity from greatest to least



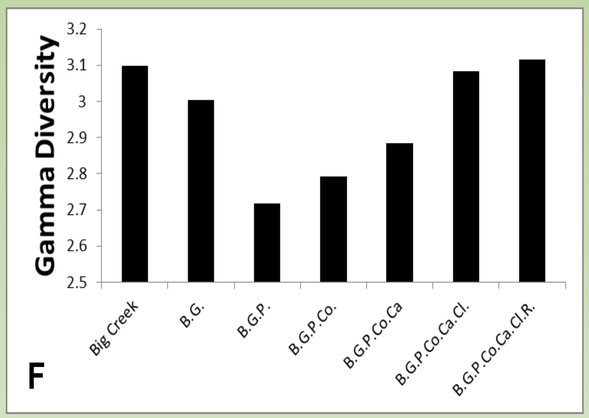


Figure E. gamma diversity of 7 hypothetical stream networks in which streams were added to Big Creek main-stem based on a randomized selection of tributaries
Figure F. gamma diversity of 7 hypothetical stream networks in which streams were added in order of light availability from least to greatest.

Methods

Benthic invertebrate samples were collected from 7 streams during mid summer using a 250µm Surber net. From samples, taxa were counted and identified in the lab. Alpha diversity was calculated for each stream using Shannon W. index of diversity such that: $H' = \sum p_i ln\, p_i$ where p_i is the proportional abundance of taxa present. Hypothetical stream networks, each comprised of 7 streams, were created by combining taxa lists from individual streams. In all analysis the main-stem Big Creek was held constant while a variety of tributary combinations were added to determine which stream network produced the greatest gamma diversity.

Discussion

- In general, macroinvertebrate diversity increased with light availability and stream size.
- As streams were added to Big Creek main-stem in order of greatest to least alpha diversity, gamma diversity maximized upon combination of the three streams with the greatest alpha diversity. These streams are vastly different in light availability and size.
- Randomized addition of streams to main-stem Big Creek revealed that gamma diversity increased most when streams exhibiting high alpha diversity were incorporated into the river network.
- Addition of tributaries to main-stem Big Creek in order of light availability (least to greatest) revealed that gamma diversity dropped with addition of low light streams but increased upon addition of streams with increasing light availability.
- This study demonstrates the importance of habitat heterogeneity in terms of maintaining biodiverse macroinvertebrate communities.