Collaborative Research:
Scale, Consumers and Lotic Ecosystem Rates (SCALER):Centimeters to Continents

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Intellectual Merit- The overarching question is: ***How can small-scale ecological experiments be applied to understand operation of entire ecological systems***? Specifically this proposal will ask ***how can we use cm- and reach-scale process measurements and consumer manipulation experiments to predict ecosystem characteristics of stream networks, and how do patterns of scaling compare across an array of North American biomes?*** The SCALER experiment: a continental scale experiment encompassing five biomes, each of which will have six sites with measurements nested at two scales (microhabitat, reach), linked to watershed models will answer these questions. Synoptic sampling will characterize watershed scale patterns. Rates of metabolism and nutrient uptake and responses to consumer exclusions will be measured at micro (0.1 m) and reach (100 m) scales. Diversity and ecosystem function will be linked at a basic level by comparing metabolism and nutrient dyamics with and without consumers larger than 0.5 cm. Experimental results will be scaled with models. Output of reach models based on microscale measurements will be compared to reach measurements, output of watershed models based on reach measurements will be compared to carbon and nutrient patterns observed with synoptic sampling. Finally, the work will compare factors influencing scaling across widely divergent biomes. A stoichiometric approach will be taken that considers interactions of source of carbon (from within or outside the system), nitrogen and phosphorus availability and transport, and how large consumers alter ecosystem stoichiometry. This approach is necessary because of strong upstream/downstream linkages and variations in the relative effects of biotic and abiotic factors at different positions within watersheds. Mechanistic explanation of how ecological measurements in streams can be scaled to watersheds will be provided, which is needed to understand both whole-system dynamics as well as to manage human impacts on entire watersheds. The experiments and modeling results will be relevant to ecology as a whole because few coupled nested experimental and theoretical scaling exercises have been undertaken in any environment. Coupling experiments and scaling exercises will characterize how plot-level experiments relate to patterns across larger scales such as landscapes (e.g., the stream network) and help understand the links between biodiversity and ecosystem function.

Broader Impacts- A key aim of this proposal is to allow extrapolation of typical experiments in streams to inform people concerned with utility or protection of the environment (i.e. human management). Management agencies and research networks (e.g., the National Ecological Observatory Network) typically make measurements or monitor across networks. Few of these networks are arranged with the idea of understanding how representative they are of processes occurring within watersheds, with the assumption that enough stations can be averaged to represent system properties. A nested design, such as employed here, is crucial for testing the ability to scale up within network measurements, and very few monitoring networks have an explicitly nested architecture. Education and outreach will be accomplished by providing managers results to help guide the placement of monitoring stations so that future measurements can be scaled up and used for broad scale comparisons. Additionally, a highly collaborative team will be created, including a mentoring plan for six graduate students, five postdoctoral students, and three young faculty members. Several open workshops will be held and other groups will be encouraged to collaborate and perform similar projects at additional sites.