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A First Look at Regional Changes in Stonefly (Plecoptera) Assemblages under Climate Change

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Many of you know that my colleagues and I have been modeling distributions of stoneflies within the middle USA. We have a good approximation of pre-European settlement distributions for 78 of 146 species known from Illinois, Indiana, Michigan, Ohio, and Wisconsin at USA Geological Survey watershed scale HUC12 (avg. 200 km^2). This sets the base distribution for stoneflies in the region. Summing modeled species within a drainage yields a pattern of species richness (Fig. 1). The richest areas are those that are unglaciated (southern third) and heavily forested. The first major product from this work is Cao et al. (2013) for Illinois. This year we will publish the regional model and its validation.

We are also examining how climate change will influence species ranges and the pattern of species richness across the area using downscaled climate data from nine climate models and two emissions scenarios throughout the 21st century. As an example of how climate change scientists think climate in the middle USA will change, the shift in heat index (how hot it feels) is presented for both Illinois and Wisconsin (Fig. 2). Even with low emissions (in orange) it will feel much hotter by the end of the century. High emissions (red) are predicted to lead to drastic changes.

Nearly 100 physical variables plus specimen data were used in Maxent software to create the pre-settlement maps. Each of these variables (forest cover, slope, surficial deposits, etc.) might have some ameliorative effect upon changing temperature and rainfall patterns. However, running the climate change models with all these variables is very time consuming, so at this point we have ran the models with climate alone, trying

to predict how the climate space of each stonefly species and the overall richness pattern might change throughout the 20th century. You will notice that we have added specimen data from Iowa and Minnesota.

Consensus current distributions derived from three climate models produced maps for each of 78 species (Fig. 3). Results were compared for these current consensus models to those future models for two climate models and high and moderate emission scenarios. For brevity, the worst case scenario is presented. It is predicted that the vast majority of the 78 modeled species will dramatically lose range (Fig. 4). Alternatively, some species will gain range, potentially *Attaneuria ruralis* Hagen is one of these. All families except Perlidae are expected to lose range within the middle USA (not figured). The pattern of species richness is also expected to shift, with many areas predicted to undergo dramatic losses of richness. Areas in Fig. 5 that have the brightest color are predicted to lose the greatest number of species. We are in the process of adding the physical variables to our predictions of the future. We hope that we see an amelioration of the effects of climate alone, otherwise, the Plecoptera assemblage of the middle USA is expected to change dramatically. Mayfly and caddisfly data will be added this summer too.

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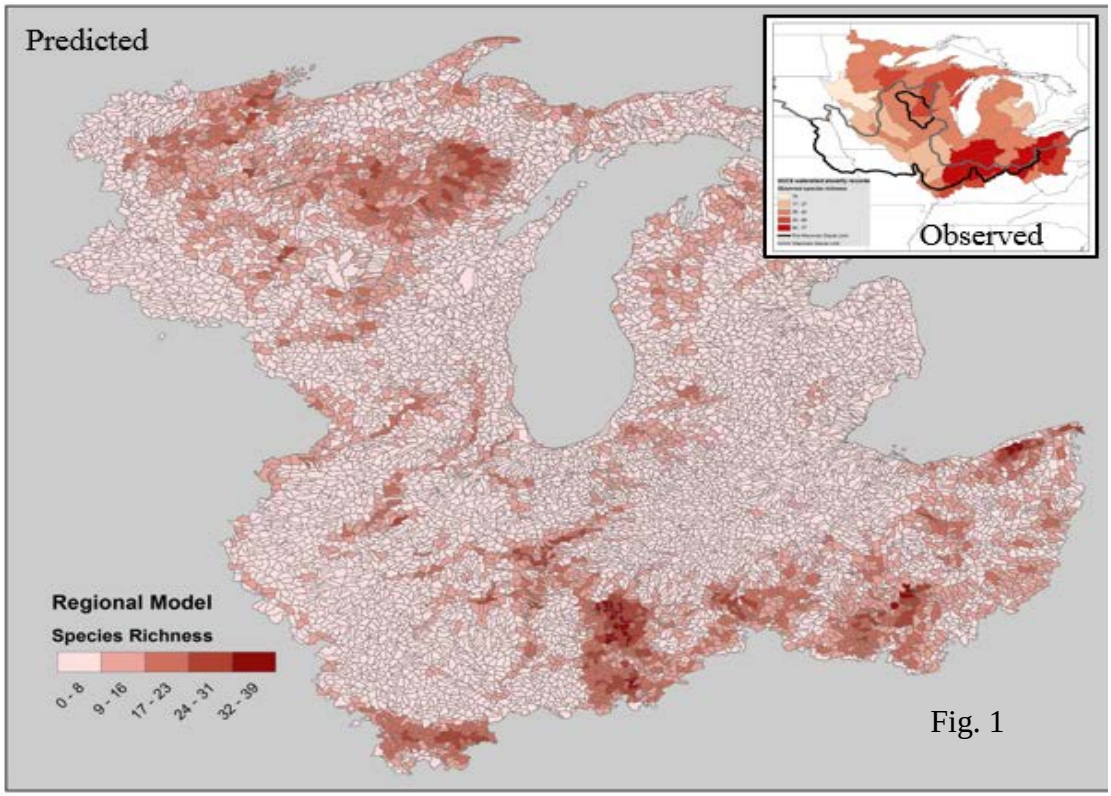

Fig. 1

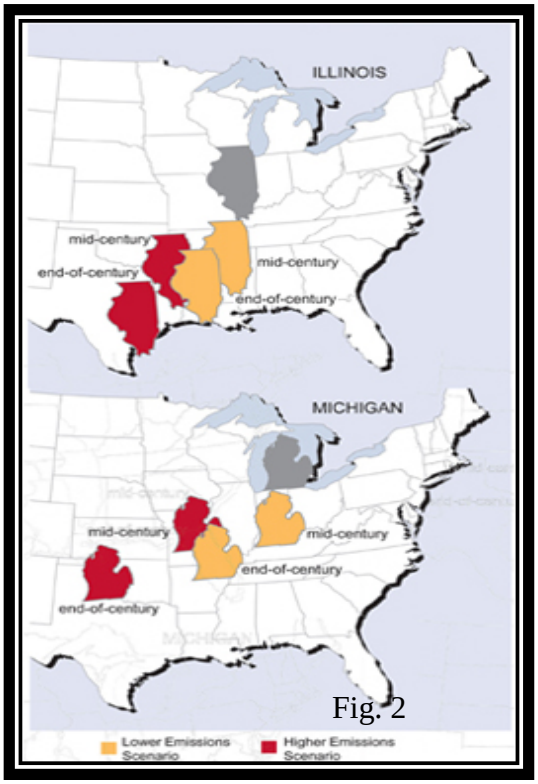

Fig. 2

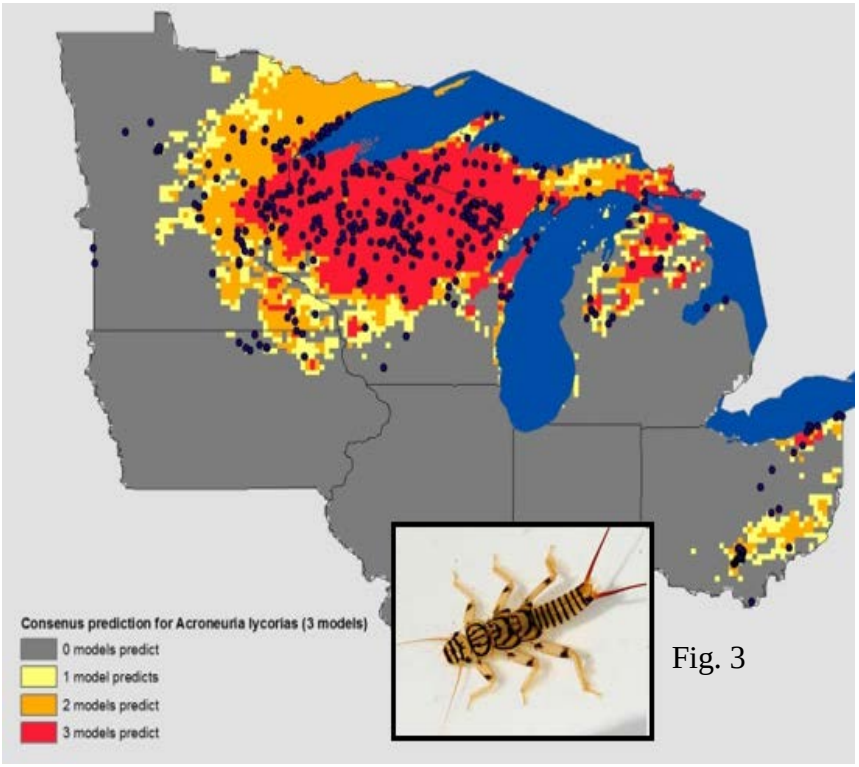

Fig. 3

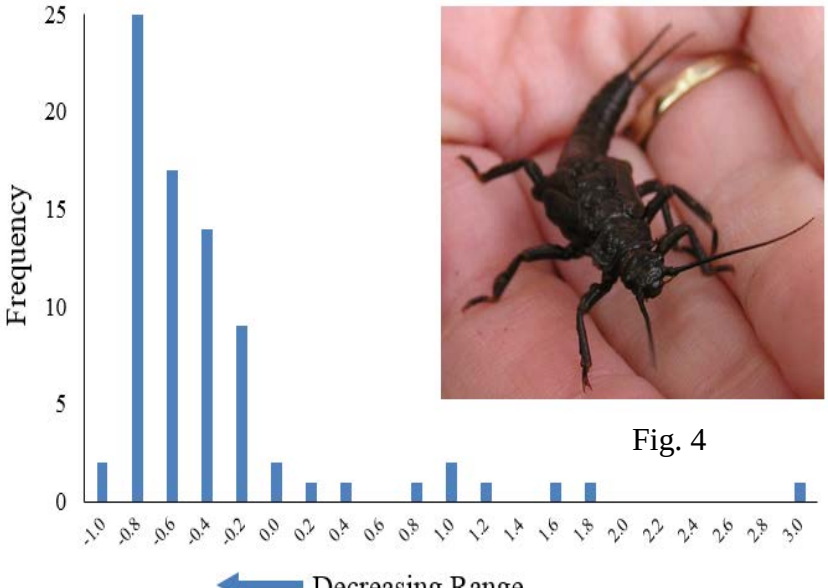

Fig. 4

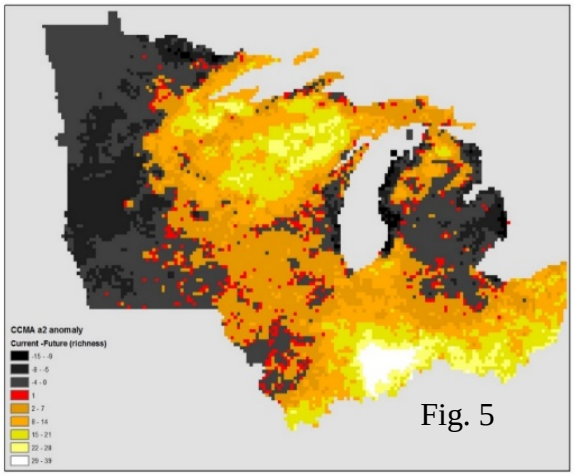

Fig. 5