

Developing a large-scale model to predict the effects of land use and climatic variation on the biological condition of USA streams and rivers

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The US EPA's National Rivers and Streams Assessment (NRSA) uses spatially balanced sampling to estimate the proportion of streams within the continental US (CONUS) that fail to support healthy biological communities. However, to manage these systems, we also must understand how human land use alters stream communities from their natural condition and how natural factors, such as climate, interact with these effects. We used random forest modeling and data from 1353 streams that NRSA determined to be in "good" or "poor" biological condition (BC) to predict the probable BC of nearly 5.4 million km of stream (National Hydrography Dataset) within the CONUS. BC was best predicted by 5 natural factors (mean discharge, mean annual air temperature [AT], soil water content, topography, major ecoregion) and 2 riparian factors that are easily altered by humans (% riparian urbanization [%Urb], % riparian forest [%Fst] cover). The model correctly predicted BC for 74% of sites, but predicted poor BC slightly more accurately (76%) than good BC (71%). Initial results showed that probability of good BC declined rapidly with increasing %Urb, but this effect leveled off in streams with >7 %Urb. Likewise, probability of good BC increased in streams with >45 %Fst. This model can be used to generate hypotheses to guide future research and test restoration scenarios. For example, BC had a U-shaped relationship with AT, with poorest BCs predicted between 10-15°C. Plots suggested a strong AT-%Fst interaction, where higher %Fst values mitigated this U-shaped response of BC to AT. These ATs correspond to latitudes that receive the greatest combination of solar radiation intensity and duration in July, and we hypothesize that thermal alteration due to riparian disturbance may be negatively affecting BC in these streams. Finally, simulations suggested that restoring riparian forests could increase the number of streams achieving good BC by 60%, and may represent a critical management tool.