Environmental drivers of stream invertebrate communities in Georgia, USA

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Background

- Georgia has >70,000 km of freshwater streams and rivers, with enormous environmental and economic impacts.
- Human activities, including pollution and land use change, affect stream biodiversity.
- Stream macroinvertebrate diversity can indicate ecosystem and watershed integrity.
- Spatial scale at which environmental factors are measured may affect conclusions about drivers of stream status.

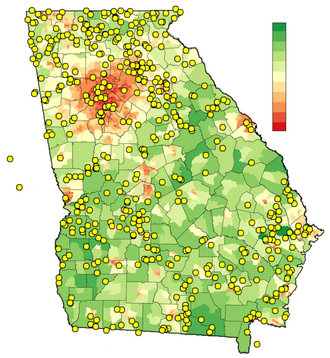

Figure 1. Sampling locations within Georgia, USA, superimposed on a map of population density.

Methods

- Integrated Georgia Environmental Protection Division stream monitoring data from 2000-2018 with land use, human population, hydrological variables, and geographical characteristics.
- Biodiversity summarized as multimetric index of biotic integrity (greater values = higher integrity).
- Used boosted regression trees to model stream invertebrate responses to environmental drivers.
- Modeled biotic index using data at 2 spatial scales: USGS HUC12 (large) and custom delineated watersheds based on digital elevation models (small).

Results

Primary drivers of stream status

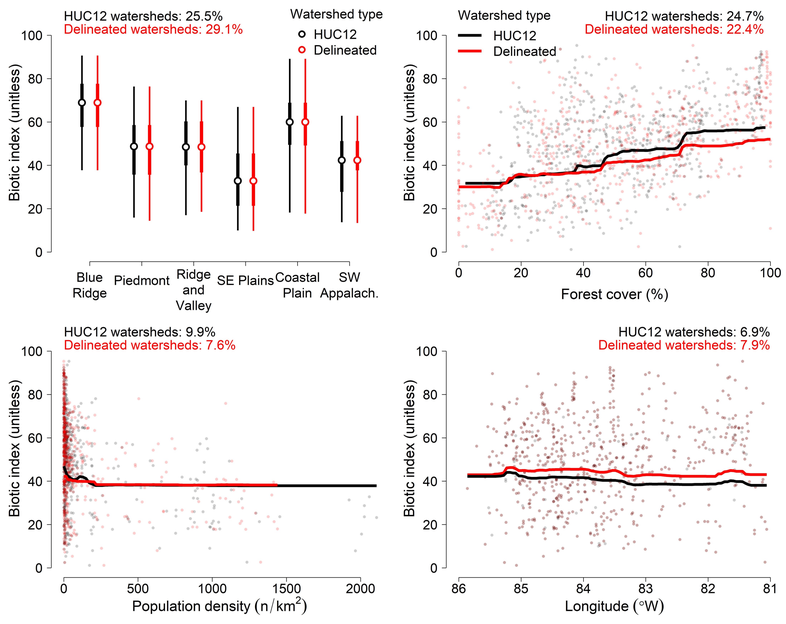

Figure 2. Boosted regression tree models explained >70% of deviance in stream biotic integrity at both spatial scales.

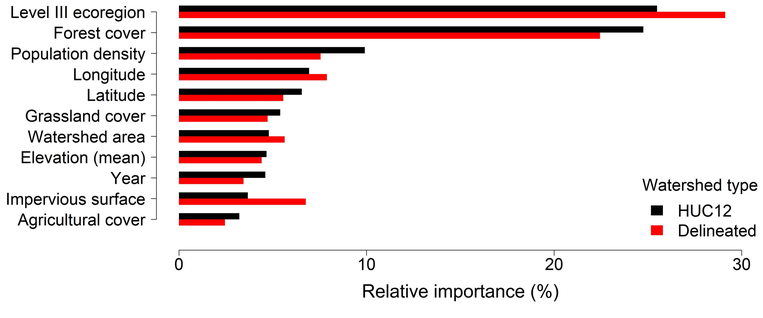

Figure 3. Relative importance of variables was similar between spatial scales (HUC12 vs. delineated watersheds); paired $t < 0.01$, 10 d.f., $p > 0.99$.

Effects of watershed scale

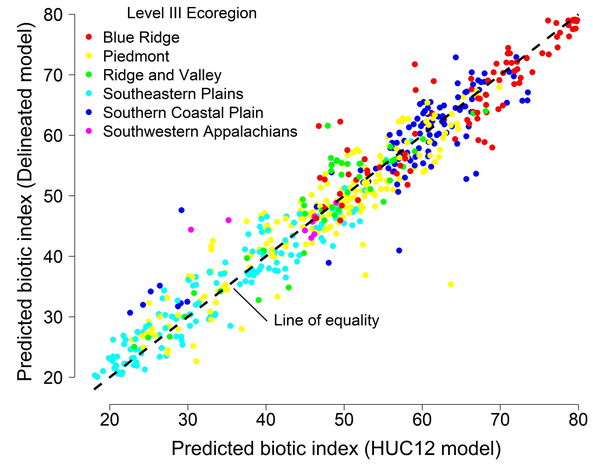

Figure 4. Predicted values were similar between models fit using HUC12 and delineated watersheds (Pearson's $r = 0.96$, $t = 88.44$, 602 d.f., $p < 0.01$). Differences between models were not related to any predictor.

Conclusions

- Stream status primarily driven by ecoregional differences and forest cover.
- Population density and longitude had small but consistent effects across spatial scales.
- Contrary to expectations, watershed scale did not affect relative influences of spatial drivers.
- Findings suggest that stream and watershed management strategies should be ecoregion-specific, and focus on forest protection within watersheds.