Spatial variability of biological assessments

Proposal to the Stormwater Monitoring Coalition

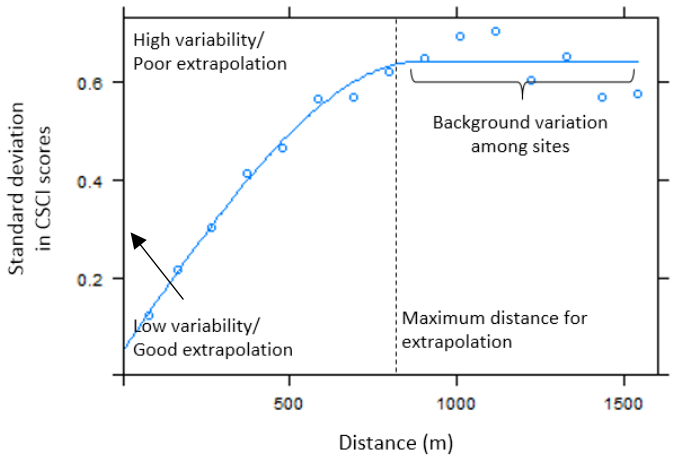
November 21, 2016

Background and purpose

Biological indices such as the benthic macroinvertebrate California Stream Condition Index (CSCI, Mazor et al. 2016) or the algal indices of biological integrity (Fetscher et al. 2014) are increasingly being used in water regulatory programs (in particular, biological objectives and nutrient numeric endpoints). As the adoption of the CSCI in the regulatory environment expands in California, questions are increasingly arising over the best way to interpret scores. Chief among these questions is uncertainty about spatial representativeness. For example, how much distance along a reach does a score from a single site represent? Because bioassessment samples are collected from relatively short lengths of a stream (generally 150 m), there is a need to extrapolate the results to adjacent reaches. Currently, there is no guidance about how far to extrapolate results, and there is very little technical data from which to develop guidance.

The California Stormwater Quality Association (CASQA) has funded a pilot project to address this critical knowledge gap by illuminating the spatial-extent limitations associated with extrapolating bioassessment results from a single location. The pilot project will explore ways to infer condition at unsampled locations based on both environmental factors (e.g., land use) and proximity to sampled locations. This pilot will be conducted in two watersheds (one in southern California, and one in the Bay Area), and will focus exclusively on CSCI scores.

Following an analysis plan created by an expert panel assembled for the CASQA pilot project, we will create spatial statistical models to estimate biological condition at unsampled locations. We plan to create spatial variograms, which show how variability between two locations changes with distance. This method is commonly used within the field of geostatistics, and has increasingly been applied to freshwater ecology and biological assessments. A hypothetical output is provided below:



The x-axis shows distance between two bioassessment sites in meters, and the y-axis shows the standard deviation in CSCI scores at sites a certain distance apart. In this example, sites close together

are very similar, with a standard deviation less than 0.1. As distances increase, the standard deviation increases until, at 800 m (indicated by the dashed line), it reaches a level corresponding to the background variability among sites far apart. In this hypothetical scenario, the variogram indicates that a single bioassessment site applies to no more than 800 m of stream-length. Shorter distances may be appropriate where higher certainty is desired. Environmental factors, like land use, can be used to increase the confidence in these estimates, and extend the distance where extrapolation is possible. We will use tools tools developed by the US Forest Service to model stream temperature (Peterson and Ver Hoef 2010, Isaak et al. 2014). If supported by the analyses, these models will allow us to propose maximum distances for the spatial extrapolation of bioassessment scores within these watersheds.

Expansion of this effort to other stream types would enhance the applicability of the products and expand their utility in supporting decisions about spatial applicability of bioassessment scoring tools. Given the widespread occurrence of "modified channels" in the SMC region, we propose to expand the existing project to evaluate the ability to extrapolate CSCI scores in modified (or engineered) channels, and to compare these relationships to the spatial extrapolations in the other two pilot watersheds completed under the CASQA funded project.

Scope and deliverables

We will take advantage of channel engineering data collected under the SMC stream survey (along with other data sources, if appropriate) to analyze the spatial fidelity of bioassessment scores in these systems. We will pick several "engineered" streams with relatively high sampling density as the focus of our analysis. We will replicate the variogram analysis conducted under the larger CASQA project to determine the similarity or difference of spatial extrapolation of CSCI scores in engineered channels.

Deliverable: Estimate distance CSCI scores can be extrapolated in southern California engineered channels

Budget: $25,000 for site selection, data analysis, and preparation of summary report

Schedule: 4 months from initiation of the project

References

Fetscher, A.E., R. Stancheva, J.P. Kociolek, R.G. Sheath, E.D. Stein, R.D. Mazor, P.R. Ode and L.B. Busse. 2014. Development and comparison of stream indices of biotic integrity using diatoms vs. non-diatom algae vs. a combination. *Journal of Applied Phycology* 26:433-450

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Peterson, E.E. and J.M. Ver Hoef. 2010. A mixed-model moving-average approach to geostatistical modeling in stream networks. Ecology 9: 644-651.