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Identifying reference conditions and quantifying biological variability within benthic macroinvertebrate communities in perennial and non-perennial northern California streams

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ABSTRACT

Identification of minimally disturbed reference sites is a critical step in developing precise and informative ecological indicators. We tested procedures to select reference sites, and quantified natural variation (inter-site and -annual variability) among reference conditions using a macroinvertebrate data set collected from 429 mediterranean- climate stream reaches in the San Francisco Bay Area, California (USA). We determined that a landscape GIS-based stressor screen followed by a local field-based stressor screen effectively identified least-disturbed reference sites that, based on NMS ordination results, supported different biological communities than sites identified with only landscape (GIS) or local (field) stressors. An examination of least-disturbed reference sites indicated that intersite variability was strongly associated with stream hydrology (i.e., perennial vs. non-perennial flow) and annual precipitation, which highlights the need to control for such variation when developing biological indicators through natural gradient modeling or using unique biological indicators for both non-perennial and perennial streams. Metrics were more variable among non-perennial streams, indicating that additional modeling may be needed to develop precise biological indicators for non-perennial streams. Among 192 sites sampled two to six times over the 8-year study period, the biological community showed moderate inter-annual variability, with the 100 point index of biotic integrity scores varying from 0 to 51 points (mean = 11.5). Variance components analysis indicated that inter-annual variability explained only a fraction (5–18 %) of the total variation when compared against sitelevel variation; thus efforts to understand causes of natural variation between sites will produce more precise and accurate biological indicators.

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