

## Eutrophication thresholds associated with protection of biological integrity in California wadeable streams

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### ABSTRACT

Eutrophication is one of the most pervasive stressors impacting streams, often leading to loss of biodiversity or change in natural functions. To protect against these adverse effects, managers can set targets for environmental indicators to limit eutrophication that are likely to maintain high biological integrity. To identify protective management targets, we evaluated the responses of three bioassessment indices (one for benthic macroinvertebrates and two for benthic algae assemblages) to five eutrophication indicators (total nitrogen [TN], total phosphorus [TP], benthic chlorophyll-a [chl-a], benthic ash-free dry mass [AFDM], and percent macroalgal cover [% cover] of the streambed). First, we used a bioassessment data set of 1249 sites in California to create logistic regression models of the likelihood of achieving several biointegrity goals for each index along increasing gradients of each indicator. Then, we evaluated eutrophication thresholds at concentrations corresponding to several relative probabilities (from 50 to 95 %), reflecting a range of policy makers' potential tolerance for risk of failing to meet biointegrity goals. Finally, we validated the thresholds with relative risk assessment, and identified the lowest validated threshold across the three indices. All eutrophication indicators were significantly associated with increased risks to biointegrity, resulting in a set of validated thresholds for each biointegrity goal. For example, thresholds of 0.24 mg/L TN, 0.05 mg/L TP, 44 mg/m<sup>2</sup> benthic chl-a, 2.5 mg/cm<sup>2</sup> AFDM, and 26 % cover would achieve index scores above the 10th percentile of reference (a biointegrity goal that has been used in certain regulatory applications) with an 80 % probability. If these thresholds were applied ambient monitoring statewide dataset, TN was the most pervasively exceeded threshold (37 % of sites), particularly within the highly agricultural Central Valley (76 %), although exceedances of TN and AFDM were also common in the urbanized South Coast region (68 % and 72 % of sites, respectively).

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