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Classification of California streams using combined deductive and inductive approaches: Setting the foundation for analysis of hydrologic alteration

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ABSTRACT

Regional classification of streams is an early step in the Ecological Limits of Hydrologic Alteration framework. Many stream classifications are based on an inductive approach using hydrologic data from minimally disturbed basins, but this approach may underrepresent streams from heavily disturbed basins or sparsely gaged arid regions. An alternative is a deductive approach, using watershed climate, land use, and geomorphology to classify streams, but this approach may miss important hydrological characteristics of streams. We classified all stream reaches in California using both approaches. First, we used Bayesian and hierarchical clustering to classify reaches according to watershed characteristics. Streams were clustered into sever classes according to elevation, sedimentary rock, and winter precipitation. Permutation-based analysis of variance and random forest analyses were used to determine which hydrologic variables best separate streams into their respective classes. Stream typology (i.e, the class that a stream reach is assigned to) is shaped mainly by patterns of high and mean flow behavior within the stream's landscape context. Additionally, random forest was used to determine which hydrologic variables best separate minimally disturbed reference streams from non-reference streams in each of the seven classes. In contrast to stream typology, deviation from reference conditions is more difficult to detect and is largely defined by changes in low-flow variables, average daily flow, and duration of flow. Our combined deductive/inductive approach allows us to estimate flow under minimally disturbed conditions based on the deductive analysis and compare to measured flow based on the inductive analysis in order to estimate hydrologic change.