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Assessment of efficient sampling designs for urban stormwater monitoring

Molly K. Leecaster, Kenneth Schiff and Liesl L. Tiefenthaler

ABSTRACT

Monitoring programs for urban runoff have not been assessed for effectiveness or efficiency in estimating mass emissions. In order to determine appropriate designs for stormwater, total suspended solids (TSS) and flow information from the Santa Ana River was collected nearly every 15 minutes for every storm of the 1998 water year. All samples were used to calculate the "true load"' and then three within-storm sampling designs (flow interval, time interval, and simple random) and five among-storm sampling designs (stratified by size, stratified by season, simple random, simple random of medium and large storms, and the first *m* storms of the season) were simulated. Using these designs, we evaluated three estimators for storm mass emissions (mean, volume-weighted, and ratio) and three estimators for annual mass emissions (median, ratio, and regular). Designs and estimators were evaluated with respect to accuracy and precision. The optimal strategy was used to determine the appropriate number of storms to sample annually based upon confidence interval width for estimates of annual mass emissions and concentration. The amount of detectable trend in mass emissions and concentration was determined for sample sizes 3 and 7. Single storms were most efficiently characterized (small bias and standard error) by taking 12 samples following a flow-interval schedule and using a volume-weighted estimator of mass emissions. The ratio estimator, when coupled with the simple random sample of medium and large storms within a season, most accurately estimated concentration and mass emissions; and had low bias over all of the designs. Sampling seven storms is the most efficient method for attaining small confidence interval width for annual concentration. Sampling three storms per year allows a 20% trend to be detected in mass emissions or concentration over five years. These results are decreased by 10% by sampling seven storms per year.