
NITRATE LOAD ESTIMATION WITH DIFFERENT METHODS, SAMPLING FREQUENCIES AND DURATION FOR ILLINOIS AGRICULTURAL WATERSHEDS

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For most streams in Illinois, water samples for nitrate concentration are taken only about nine times a year. Based on these discrete nitrate concentration data, loads of nitrate passing a gauging station during the period of study may be calculated using various load estimation methods. To examine the accuracy and precision of these nitrate load estimates, a Monte Carlo sub-sampling study was conducted using six years of daily nitrate concentration and daily average discharge data at one gauging station on a medium size river in central Illinois draining predominantly agricultural lands. The "true" nitrate loadings were calculated using the entire data set. The accuracy and precision of the computed annual nitrate loads were estimated for (i) various load estimation methods, (ii) different periods of record and (iii) various sampling frequencies.

Five load estimation methods were tested in this analysis: rating curve, minimum variance unbiased estimator, smearing estimator, ratio estimator, and flow-weighted estimator. The periods of record used in this analysis were one, two, three and six years. The sampling frequencies included weekly, bi-weekly and 4-weekly for all the periods of record, and 6-weekly and 8-weekly for the six-year record only.

A desired accuracy could be achieved either by sampling more frequently or by monitoring the site longer. Also, for given record length and sampling frequency, an expected accuracy can be estimated based on the results of this study. In most cases the regression-based estimators were positively biased when applied to the subject study site. It was also found that none of the two bias reduction estimators, minimum variance unbiased estimator and smearing estimator, decreased the bias.

On the contrary, those estimators had higher bias, which resulted in increased RMSE.

Other three estimators, the rating curve, the simple ratio, and the flow-weighted estimator, had significantly smaller RMSE for all sampling frequencies and all periods of record.

Results presented in this paper can be used as guidance for the design of sampling programs, in particular for the selection of load estimation methods, sampling frequencies and duration of monitoring in the determination of nitrate mass discharged from similar agricultural watersheds.