Impact of Sampling Frequency on Annual Load Estimation

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Background

Compliance with water quality standards for sediment and nutrients is typically based on the collection and analysis of grab samples. These data generally are not collected with enough frequency or regularity to provide representation of the constituent loading, yet regulatory decisions and the investment of significant resources for water quality improvement are routinely based upon these numbers. This study examines the impact of sampling frequency on resulting load estimates at two distinct locations on the Little Bear River in northern Utah.

Methods

•In situ turbidity measurements were used to generate high frequency estimates of TP and TSS though surrogate relationships.

Site	Constituent	Equation
Paradise	Total Phosphorus	$TP = 0.209 + 0.000798 * Turb + 0.0386 * Z$
	Total Suspended Solids	$TSS = 3.58 + 1.31 * Turb$
Mendon	Total Phosphorus	$TP = -0.0341 + 0.0053 * Turb + 0.0949 * Z - 0.00404 * Turb * Z + 0.0832 * Y - 0.00871 * Y * Turb$
	Total Suspended Solids	$TSS = 0.341 + 1.41 * Turb$

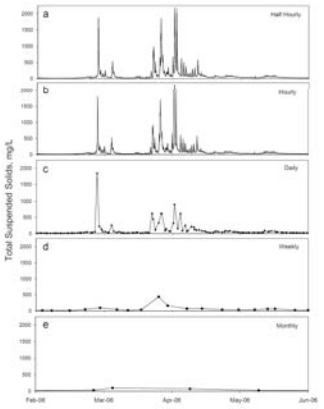
Variable	Description
TP	Total Phosphorus, mg/L
TSS	Total Suspended Solids, mg/L
$Turb$	Turbidity, NTU
Z	categorical variable for spring runoff ($Z = 1$) versus baseflow ($Z = 0$)
Y	categorical variable for $Turb$ <10 NTU ($Y = 1$) versus $Turb$ >10 NTU ($Y = 0$)

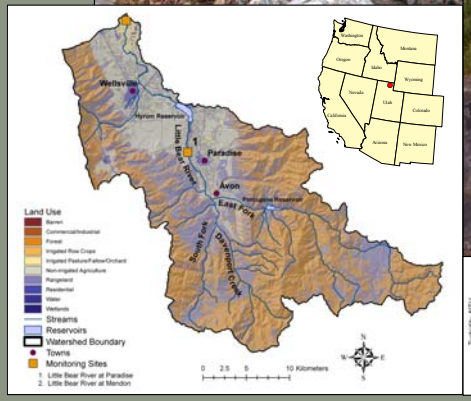
•Concentration estimates were paired with discharge data to estimate annual TP and TSS loads- these are the reference loads.

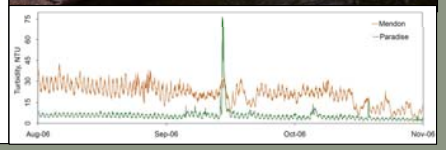
$$W = \sum_{i=0}^{n} Q_i C_i x$$

•The high frequency records were subsampled to create random subsets representing hourly, daily, weekly and monthly sampling frequencies.

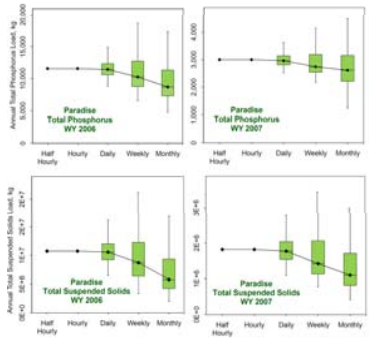
•Subsets were also created to examine the effects of randomizing the time of day and the day of week of sampling.

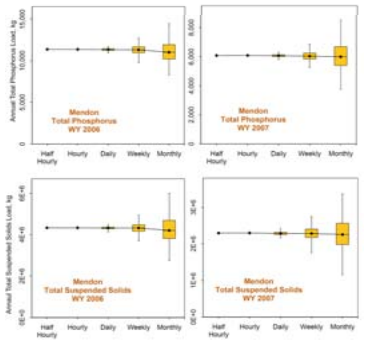






Results- Sampling Frequency





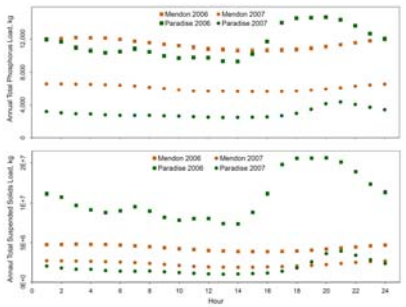
Upper Watershed: Paradise

•Less regulated, less impacted
•Higher peaks, flashier flow regime
•Coarse sediments
•Phosphorus is 60% particulate, 40% dissolved
•Greater bias in load calculations
•Low probability of achieving reference load

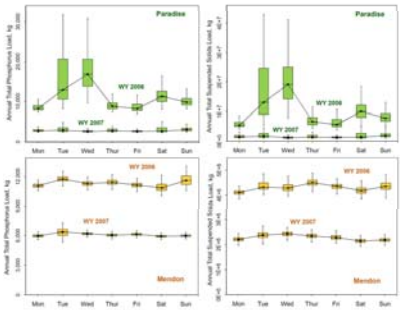
Lower Watershed: Mendon

•Influenced by reservoir release, ag return flows, wastewater treatment lagoons
•Higher baseflow
•Fine, lacustrine sediments
•Phosphorus is 40% particulate, 60% dissolved
•Less bias in load calculations
•Higher probability of achieving reference load

Results- Timing of Sample Collection



Annual loads calculated from consistently sampling at the same time each day show variability from one hour to the next. The trends are distinct for each site, but are similar across variables and years. Differences within a day are likely due to diurnal fluctuations in turbidity, TP, and TSS.



Annual loads calculated by sampling weekly on the same day of the week show variability from day to day, especially at Paradise in 2006.

Conclusions

•Using high frequency data to calculate loads provides increased resolution and accuracy.
•Bias from reference loads varies between sites.
•Daily sampling may approximate reference loads, but is infeasible.
•Weekly and monthly sampling do not adequately approximate the reference loads.
•The hour of day and day of the week of sampling can impact load estimation.