Nutrient and Sediment Research on the Lower Minnesota River

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Research Tasks:

1. Biologically-available and unavailable nutrient fractions of river loads
2. Kinetic and equilibrium processes between aqueous phases and total suspended solids
3. Diffusive fluxes from sediment and sediment characteristics
4. Budgetary analysis
5. Reporting

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1. Biologically-available and unavailable nutrient (primarily P) fractions of river loads

In order to better understand partitioning of particulate and dissolved inorganic and organic P fractions and loads in the Lower Minnesota River (LMR), and potential impacts on eutrophication and oxygen demand, research will be conducted to examine seasonal variations in P loads using a fractionation scheme that distinguishes between biologically-available and unavailable particulate P. This fractionation scheme (Table 1) will supplement currently monitored P fractions such as TP, TSP, TRP, SRP, PP, etc, being determined by other agencies.

Table 1. Operationally-defined particulate phosphorus fractions. BA = biologically available to algae either in present form or via recycling processes (eH and pH reactions; mineralization); BU=biologically unavailable to algae in present form and subject to burial or other removal from the system.

Operationally-defined fraction	Biological availability
Loosely-bound P (Loosely-sorbed P; $CaCO_3$-P)	BA
Iron-bound P	BA
Labile organic P (Labile organic P and polyphosphates)	BA
Aluminum-bound P	BU
Calcium-bound P (Apatite)	BU
Refractory organic P	BU

Water samples will be collected from RM 40.0 and RM 3.5 at several time intervals and/or different flow regimes during the ice-free period in conjunction with other sampling programs in order to assess input-output dynamics for the lower Minnesota River. The TSS collected at sampling stations will be concentrated via settling and centrifugation or via filtration for analysis. Work on kinetic and equilibrium processes will be conducted in conjunction with this task (see task 2). Information obtained will be used to calculate loadings of BA and BU to supplement mass balance analysis. It is important to collect samples during periods of moderate to higher flows in order to assess watershed-derived TSS composition. In contrast, TSS at low flow may be dominated by algae. This task includes interim updates and summary reports for modeling needs.

2. Kinetic and equilibrium processes between aqueous phases and total suspended solids

In conjunction with Task 1, additional water will be collected at the sampling stations for analysis of kinetic and equilibrium processes between TSS and aqueous phases. These processes will be examined under in situ TSS concentration (load) and temperature conditions observed at the time of collection. TSS will be concentrated via settling and centrifugation. The water medium to be used will be determined at a later date, but it will closely reflect ionic characteristics of the lower Minnesota River. Phosphate as KH_2PO_4 will be added to the water medium prior to exposure with TSS to adjust the soluble P concentration.

For kinetic studies, TSS will be subjected to a moderately high concentration of P. Samples for SRP will be collected at varying time intervals to determine kinetic characteristics. For equilibrium studies, TSS will be exposed to a range of P concentrations for up to 24 hours. For both studies, temperature will be controlled using a darkened environmental chamber.

As with task 1, it will be important to collect TSS during periods of moderate to elevated flows in order to assess kinetic and equilibrium processes for TSS derived from the watershed (versus algal-dominated TSS). This task includes interim updates and summary reports for modeling needs.

3. Diffusive fluxes from bottom sediments and sediment characteristics

3a. Sediment characteristics. The physical and chemical composition of sediments deposited in the Lower Minnesota River will be examined for comparison with diffusive fluxes of nutrients from sediments. It is anticipated that sediment samples will be collected primarily within the navigation channel located in the lower third of the LMR stretch. Previous observations have reported that fine-grained, flocculent sediments can be stored in this region of the river and may contribute to diffusive N and P fluxes. Sediment cores, or sediment collections via ponar, will be collected at 10-15 randomly selected sites within the zone of flocculent sediment storage in the LMR during the summer period for analysis. The upper 5-10 cms of surficial sediment will be analyzed. Listed below are necessary sediment variables. This task includes interim updates and summary letter reports for modeling needs.

MOISTURE CONTENT, %

SEDIMENT DENSITY, g/mL

ORGANIC MATTER (Loss-on-ignition), %

TOTAL ORGANIC CARBON, %

TOTAL SEDIMENT NITROGEN, mg/g

EXCHANGEABLE NITROGEN, mg/g

TOTAL SEDIMENT PHOSPHORUS, mg/g

LOOSELY-BOUND PHOSPHORUS, mg/g

IRON-BOUND PHOSPHORUS, mg/g

ALUMINUM-BOUND PHOSPHORUS, mg/g

CALCIUM-BOUND PHOSPHORUS, mg/g

RESIDUAL ORGANIC PHOSPHORUS, mg/g

POREWATER DISSOLVED ORGANIC CARBON, AMMONIUM-N, NITRATE-NITRITE-N, SOLUBLE PHOSPHORUS, mg/L (IF OBTAINABLE)

PARTICLE SIZE DISTRIBUTION (SAND, SILT, CLAY)

3b. Diffusive fluxes. Intact sediment cores will be collected from the same navigation channel region of the LMR, as described above, for determination of diffusive nitrogen (as NH_4-N) and phosphorus (as SRP) fluxes. Locations and stations can be determined at a later date as more information is obtained on sediment characteristics in this part of the LMR. This task includes analysis up to 48 intact sediment cores for nutrient flux. The study is designed to examine fluxes at different temperatures during the ice-free period for calibration and verification of the model. Incubation temperatures will range from < 10 C to 25-30 C. Replicate sediment cores (6 or more) will be incubated at the collection temperature. Fluxes will be examined under oxic and anoxic conditions. This task also includes interim updates and summary letter reports for modeling needs.

4. Budgetary analysis.

Information on inputs to the Minnesota River (i.e., Minnesota River at Jordan and various tributary, WWTP, and other point source inputs) and the output to the Mississippi River at Ft. Snelling will be evaluated via mass balance to examine sediment, nitrogen, and phosphorus dynamics and source-sink relationships in the lower Minnesota River. Tributary and point-source inflows and outflow loads will be estimated via the software program FLUX and/or other tools. Evaluations will be made on annual and seasonal time scales over a 3-year period (2004 through 2006). Report will be provided for each year of research.

5. Reporting

A final report describing special studies (listed above) in relation to budgetary analyses will be produced by December 2007