Session I1: Effects of Diel Cycling on Stream Conditions

Room A105
10:00 – 11:30 am

0287
I1-1

Effects of Daily Fluctuations in Streamflow on Stream Metabolic Activity Calculations

Alba Argerich[1], Sherri L. Johnson[2], Roy Haggerty[3] and Ricardo González-Pinzón[3]

[1]Dept. of Forest Ecosystems and Society, Oregon State Univ., Corvallis, Oreg., USA, [2]USDA Forest Service Research, Corvallis, Oreg., USA, [3]Dept. of Geosciences, Oregon State Univ., Corvallis, Oreg., USA

Stream metabolic activity (*e.g.*, respiration, primary production, or nutrient uptake) is highly influenced by hydrologic conditions, not only because they determine the supply rate of reactive solutes to the biota but also because they determine habitat availability. The conventional method to calculate stream metabolism (*i.e.*, the open-channel method) requires the measurement of the atmosphere-stream gas exchange rate, discharge, travel time, and the wetted channel area, in addition to continuous measurement of dissolved oxygen concentration and water temperature. All of these except oxygen and temperature are normally assumed to be constants. We hypothesize that transient effects might be important in small streams with a strong diel streamflow signal and that they become more relevant during baseflow conditions, when diel fluctuations in streamflow are more conspicuous. To test this hypothesis we measured ecosystem respiration and gross primary production using the open-system, two-station diel approach under different discharge conditions. Additionally, we performed injections of a metabolically-active tracer (resazurin which turns to resorufin in the presence of aerobic respiration), and a conservative tracer (NaCl). The study was conducted in WS01, a steep, 2nd-order stream located in the H.J. Andrews Experimental Forest in the western Cascade Mountains of Oregon. This stream shows a strong diel variation in discharge, particularly in summer. Results show that metabolic rates during summer exhibit daily fluctuations that do not always coincide with the fluctuations in streamflow. Additionally, ignoring the effects of diel fluctuations in discharge on water velocity and wetted channel area may lead to inaccurate estimation of metabolic rates using the open-channel method, especially during summer.

0151
I1-2

Diel Variation in Sediment Load in a 5th Order River in SE Idaho – Temporal Variation and Impacts on Load Estimates

Richard Inouye[1], Andrew Ray[2] and Greg Mladenka[1]

[1]National Science Foundation, Arlington, Va., USA, [2]US Geological Survey, Bozeman, Mont., USA, [3]Idaho Dept. of Environmental Quality, Pocatello, Id., USA

Accurate estimates of suspended sediment loads in flowing water are necessary for regulatory and assessment needs, but estimate accuracy may be strongly influenced by the sampling regime that is employed. We report how timing of sampling can influence total suspended sediment (TSS) load estimates at four sites in a fifth-order river in SE Idaho. We used a near-continuous (30-min), multi-year (2003-2010) record of optical turbidity and discharge, together with empirical relationships between turbidity and TSS concentrations, as the basis for our analyses. Here we focus on diel variation in TSS loads and examine how the daily tming of sample collection affects the accuracy of daily TSS load estimates. Using a single measurement, the maximum daily deviation for a daily load estimate was as much as 25% from our best estimates. Loads were typically lowest in the afternoon. Diel variation in sediment load was apparent at each site and in each year, however the consistency of that variation varied among years, within years, and among sites. Diel patterns were most consistent during summer months. These results illustrate how the timing of sampling may influence our ability to accurately characterize TSS loads.

0076
I1-3

Diel Cycles Confound Synoptic Sampling in a Metal-Contaminated Stream

Briant Kimball[1], David Nimick[2], Robert Runkel[3] and Kathrine Walton-Day[3]

[1]US Geological Survey, Salt Lake City, Ut., USA, [2]US Geological Survey, Helena, Mont., USA, [3]US Geological Survey, Lakewood, Colo., USA

Sources of contaminants or other solutes in streams are commonly determined using synoptic sampling. The solute concentration and streamflow data determined at multiple sites are used to construct mass-loading profiles to identify and quantify sources and sinks of the solute. However, biogeochemical processes that respond to the solar photocycle produce persistent diel (24-hour) concentration cycles that complicate interpretation of the mass-loading profiles. Sampling was designed to distinguish changes that one would observe in truly simultaneous synoptic sampling from those changes one does observe due to diel cycling because sampling simultaneously at multiple points is not practical over a typical study reach.The experiment was in Silver Bow Creek, a stream draining the historical mining town of Butte, Montana. Silver Bow Creek was chosen as the study site because (1) the metal mass-loading data were needed to evaluate cleanup efforts that removed and replaced substantial mine-waste deposits from the channel and floodplain and (2) previous studies had shown substantial diel cycling of metals and nutrients occurred. Synoptic and diel sampling were conducted in August 2010 and 2011 along a 8.6-km reach downstream of Butte. Diel sampling (conducted every 60-90 minutes) near the upstream and downstream ends of the study reach showed maximum daily increases for pH (2 units), As (61%), Mn (304%), U (125%), V (158%), and Zn (990%). The first synoptic sampling of 22 sites started at 10:00 and lasted until 18:00 hours. These mass-load profiles showed Zn load increasing and As, U, and V loads decreasing downstream. The apparent Zn increase is thought to be due to affects of diel cycling in which Zn concentrations are highest in the morning and As, U, and V concentrations are highest in the afternoon. An additional set of synoptic samples was collected over a 15 minute period at selected sites, and showed small load changes resulting from downstream changes rather than diel variation. The load profiles for the first detailed and subsequent short synoptic matched when the concentration data were converted to values normalized to a single time.

0065
I1-4

Diel Cycles in Major and Trace Elements in Streams: Anthropogenic Effects on, and Additions to, Natural Cycles

Julia Barringer, Pamela Reilly and Zoltan Szabo

US Geological Survey, West Trenton, N.J., USA

Diel cycles in concentrations of dissolved trace elements, nutrients, and other constituents result from both natural and anthropogenic inputs to streams. Fluctuations in irradiance, photosynthesis and evapotranspiration lead to cycles in streamwater temperature (T), pH and dissolved oxygen (DO), and in groundwater discharge to streams. Cycles in particulate trace elements also can arise from redox-promoted precipitation and from nocturnal sediment stirring by invertebrates. Anthropogenic discharges to streams and groundwater can alter natural cycles or create new cycles in introduced constituents.

In New Jersey, the US Geological Survey, in cooperation with the New Jersey Department of Environmental Protection, investigated and compared diel cycles (particularly timing of peak concentrations) in trace elements, nutrients, and other constituents among three streams in contrasting settings. Waters were slightly alkaline in two streams; one of which had mining and sewage inputs, the other had treated wastewater inputs. Waters were acidic in the third stream with inputs mainly from surrounding wetlands. The mining-impacted stream cycles mainly were typical of alkaline waters, with pronounced dissolved metals cycles that were anti-coincident with pH and T cycles and with the anionic arsenic cycle. These cycles are due to controls by pH and T cycles on sorption and desorption reactions for cations and anions. Such cycles generally were not apparent in the stream with treated wastewater inputs, however. Dissolved arsenic cycles were absent from the acidic wetland-influenced stream because of inhibition of desorption by acidic pH. Where discharges of sewage and treated wastewater occurred, double-peaked cycles and (or) night-time lows in some major and trace element concentrations were present. Cycles in particulate metals and arsenic were observed in the stream with mining inputs; particulate iron and manganese cycles also were observed in the acidic stream. In both streams, nocturnal invertebrate sediment stirring seemed the likely explanation. The results for the New Jersey streams demonstrate departure from, and additions to, natural cycles created by anthropogenic disturbance. Further, the results illustrate that widely differing results for chemical constituents in streamwater can be obtained, depending upon time of sampling.