Vertical hydrologic exchange and ecosystem metabolism in a Sonoran Desert stream

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Abstract

Hyporheic metabolism in a Sonoran Desert stream was examined, focusing on the sources of detritus supporting hyporheic respiration. Two alternative hypotheses were specifically addressed: (1) organic matter derived from the surface stream supports hyporheic respiration, and (2) detritus buried during flash floods supports hyporheic respiration. As predicted for the surface-derived organic matter hypothesis, respiration was lowest immediately following flash floods and increased significantly with time after flood ($P < 0.001$). Hyporheic respiration ranged from 0.05 mgO sub(2)/L sediments/h immediately following a flash flood to as high as 4.41 mgO sub(2)/L sediments/h late in algal succession. Respiration was significantly correlated with surface algal biomass during two spring/summer successional sequences ($P < 0.05$; partial correlation coefficients 0.58 and 0.88). Respiration was also consistently higher in downwelling than upwelling zones with overall mean rates of 1.12 and 0.46 mgO sub(2)/L sediments/h, respectively. Respiration exhibited a distinct diel pattern with highest rate coinciding with time of maximum photosynthesis and was also significantly correlated with dissolved organic carbon concentration ($P < 0.05$), further supporting the hypothesis of hyporheic dependence on algal production. Flash floods bury organic matter that is also respired in the hyporheic zone; however, based upon storage of organic carbon immediately following floods, an average of only 15% of the observed respiration could be supported. We conclude that hyporheic respiration in Sycamore Creek is tightly linked to surface production. It is spatially distributed in biotic "hot spots" where surface waters enter hyporheic sediments and is most likely supported by organic matter that is supplied as dissolved organic carbon, perhaps from algal production.

Periphyton nutrient limitation and other potential growth-controlling factors in Lake Okeechobee, U.S.A.

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Abstract

Periphyton nutrient limitation was assessed in Lake Okeechobee, a large, shallow, eutrophic lake in the southeastern U.S.A. Nutrient assays were performed to determine if the same nutrients that limit phytoplankton also limit periphyton growth in the lake. Nutrient diffusing clay substrates containing agar spiked with nitrogen, phosphorus, or both, along with nutrient-free controls, were incubated at four sites in the lake. Three sites were located in a pelagic–littoral interface (ecotone) and one site was located in the interior littoral region. Incubations lasted for 20–26 days, and were repeated on a quarterly basis between 1996 and 1997, to incorporate seasonal variability into the experimental design. The physical and chemical conditions at each site also were measured. Periphyton biomass (chlorophyll *a* and ash-free dry mass) was highest at the littoral and northern ecotone sites. At the littoral site, nitrogen limited biomass in four of five incubations, although the largest biomass differences between the treatments and controls (≤ 3 μg cm^{-2} as chl) were probably not ecologically significant. Periphyton biomass at the western and southern ecotone sites was low compared to the other two sites. Increases in water column depth and associated declines in light penetration strongly correlated with periphyton growth and suggested that they may have limited growth most often at all three ecotone sites. Nitrogen also was found to limit periphyton growth approximately 20% of the time at the ecotone sites and phosphorus was found to limit growth once at the west site.

Effects of experimental floods on periphyton and stream metabolism below a high dam in the Swiss Alps (River Spöl)

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We investigated the effects of an experimental flood regime on periphyton and stream metabolism downstream of a large reservoir. Three floods took place in summer of 2000 and 2001 and two floods in summer of 2002. Residual flow in the River Spöl was <2.5 m^3s^{-1}. The experimental floods lasted 9 to 11 hours with peak flows ranging from 12 to 55 m^3s^{-1}. Periphyton was collected in the River Spöl (impact site) and in a reference stream in 1999 (pre-flood) and before and after each flood from 2000 to 2002. We measured ecosystem metabolism with the single station diel oxygen method a few days before and after floods in the River Spöl. Floods temporarily reduced periphyton biomass, but the disturbance impact and recovery patterns were not uniform among floods, thus resulting in high inter-annual variation in seasonal biomass patterns. The average periphyton biomass in the River Spöl even increased after a transient reduction in 2000. A principal component analysis indicated a persistent shift in the structure of the diatom community at the impact site. The floods reduced gross primary production and to minor extent ecosystem respiration, resulting in a transient decline in the P/R ratio. However, ecosystem metabolism recovered relatively fast. The new flow regime increased ecosystem dynamics, but it may take several years until the autotrophic energy base becomes adapted to the new and more dynamic flow regime.