Influence of stream size on ammonium and suspended particulate nitrogen processing

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ABSTRACT: We used $^{15}NH_4$ tracer additions to determine travel distances of ammonium (NH4) and suspended particulate organic nitrogen (SPON) in six streams ranging from second to fifth order located within a single watershed on the North Slope of Alaska. Based on the distribution of ^{15}N stored in stream bottom compartments (primary producers or grazers), we estimated NH_4 travel lengths. We used a two-compartment model to estimate the travel length of SPON based on the distribution of source ^{15}N on the stream bottom and SPO ^{15}N in the water column. Both NH_4 and SPON travel lengths (S_w and S_p, respectively) increased with discharge primarily due to changes in depth and velocity. Variation in the vertical mass transfer coefficient (v_f) of both NH_4 and SPON did occur among the streams but was not related to stream size and was relatively small compared to the change in physical characteristics. Thus, in the Kuparuk watershed, physical gradients outweighed biological or chemical changes as controls on NH_4 and SPON travel length. The one exception was the Kuparuk fertilized reach, where phosphorus fertilization greatly increased biological activity and NH_4 processing compared to unaltered streams. Longitudinal gradients in major biological driving variables such as litter inputs, debris dams, and shading are absent in the Arctic, perhaps explaining the relatively uniform NH_4 - v_f. Watersheds in other biomes may show differing degrees of physical versus biological/chemical controls. A conceptual model is presented for comparing the relative strength of these controls among different watersheds. Strong relationships between discharge and travel length should greatly aid development of watershed models of nutrient dynamics.

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