Seasonal and annual watershed nitrogen export within the Willamette River Basin

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Anthropogenic nitrogen (N) enrichment is recognized as one of the leading threats to aquatic ecosystems and water quality. In order to manage this threat, we need to understand patterns of N input to the landscape and export from watersheds. Nitrogen export from watersheds is influenced by hydrologic flows, land use/cover and the timing and spatial arrangement of N inputs and removal within the basin. We examined the relationship between N inputs and watershed N export for 23 monitoring stations between 2002 and 2006 within the Willamette River Basin. Net N inputs to the landscape (fertilizer, manure, atmospheric deposition, N fixation, point sources, and agricultural export) were calculated from local and national information including Extension recommendations for crop-specific fertilizer application and national models of atmospheric deposition. We hypothesized that N export would be strongly correlated with N inputs, and that much of the N inputs come from agricultural activities in the valley. We also expected that N export would be strongly seasonal, reflecting the Mediterranean climate of western Oregon. We found a wide range of areal N export from the monitored WRB sub-basins, ranging from 1 to nearly 70 kg N ha^{-1} yr^{-1}. Watersheds with lower per unit area export reflected their origins in the predominantly forested Cascades, while the higher N export basins had a greater proportion of agricultural areas, particularly areas with high N-requirement cultivated crops. Export was strongly seasonal, with at least 60% and up to 95% of the N export occurring during the fall and winter months. Export varied greatly from year to year, responding to interannual changes in precipitation and runoff, suggesting that changes in hydrology will have important effects on N export downstream and to coastal areas in the future. Fertilizer N inputs were well correlated with N export from the sub-basins. Across the WRB, N export appears to be more strongly related to fertilizer application rates, rather than area of agriculture, indicating the importance of specific crops and crop practices. This reinforces the need for good tracking of N inputs to inform water quality monitoring and management.