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Nitrogen isotope ratios of aquatic organisms and sediments – New indicators of human impacts on river ecosystems

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Measurements of ^{15}N natural abundances ($\delta^{15}N$) of organisms and organic pools such as sedimentary and suspended particulate organic matter in river environments can provide useful information regarding sources, transformations and food web transfer of nitrogen in the watershed. The purpose of our study, conducted in the Lake Biwa watershed (area, xxx km^2), Japan, was to examine if such information can be used as an indicator of the perturbation of river ecosystems especially due to eutrophication caused by the anthropogenic loading of nitrogen. Samples were collected at near the mouth of thirty two rivers flowing into the lake in order to cover a wide range of area (2 - 400 km^2), population density (40 to 3,200 pop./km^2) and land use patterns of the watershed. We found that $\delta^{15}N$ values of the biota (submerged plant, aquatic insects, bivalves, fish) and organic pools (sedimentary, epilithic and suspended particulate organic matter) concomitantly increased with increasing population density and other variables (nutrient concentrations, electric conductivity and land use patterns) that are indicative of anthropogenic N-loading. This finding is consistent with the results of other studies indicating that $\delta^{15}N$ of nitrogen derived from sewage and other anthropogenic sources is generally high. We used the $\delta^{15}N$ data to analyze food web structure of river communities including epilithon (producer), snail (consumer) and fish (predator). Results indicated that the isotopically defined trophic position of fish ($TL = \{\delta^{15}N_{fish} - \delta^{15}N_{epilithon}\} / 3.2 + 1$) tended to decrease with increasing eutrophication, suggesting a systematic alteration of food web structure with increasing nitrogen loading. The above results suggest that nitrogen stable isotope ratios of biota and organic pools are useful in detecting changes in nitrogen loading and community alterations in river ecosystems. We discuss merits and limitations of the use of nitrogen stable isotope indicators as a diagnostic tool that facilitates effective management of watershed.