ASSESSMENT OF STABLE NITROGEN ISOTOPES IN
FINGERPRINTING SURFACE WATER INORGANIC NITROGEN SOURCES

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Abstract. In many coastal areas of Louisiana, surface water quality is deteriorating rapidly due to elevated nutrient input from agricultural, domestic and industrial sources. This study investigates the potential use of natural abundance variations in $^{15}$N/$^{14}$N ratios for identification and tracing surface water inorganic N sources. Surface water samples were collected from streams and point sources in Louisiana and analyzed for NH$_4^+$-N, NO$_3^-$-N and associated $^{15}$N/$^{14}$N ($\delta^{15}$N %o) concentrations. Ammonium-N from domestic sewage and industrial discharge point sources was found to have distinct $\delta^{15}$N ranges. Domestic sewage discharge into a slow flowing stream was traced for about 30 km downstream using $\delta^{15}$N/$^{14}$N ratios. At the sewage point source NH$_4^+$-$\delta^{15}$N values averaged +43%o and increased linearly to +162%o with distance from the discharge. In a larger stream with a greater flow velocity the NH$_4^+$-$\delta^{15}$N surface water signature of an industrial discharge source was identifiable for approximately 1 km from the point source. Surface water NO$_3^-$-$\delta^{15}$N values generally ranged from +1 to +99%o and no significant association was observed between $\delta^{15}$N values with distance from the domestic sewage and industrial point sources. The discrete NH$_4^+$-$\delta^{15}$N signatures of domestic sewage and industrial point sources compared to downstream surface water NH$_4^+$-$\delta^{15}$N values suggest that N isotopic ratios have the potential to be used as tracers in surface waters contaminated with inorganic N.

1. Introduction

In many regions of the Gulf Coast, including Louisiana, surface water quality is deteriorating. Water bodies in the northern portions of these coastal areas are rapidly becoming eutrophic and anoxic. Domestic waste discharge is becoming an increasing problem to surface water quality because of inadequate sewage treatment and population increases. Agricultural runoff and industrial waste discharge also results in large quantities of N entering surface water bodies. Source identification of this N is needed to restrict or eliminate future N loading.

Natural variations in N stable isotopic ratios ($^{15}$N/$^{14}$N) have been used successfully in source identification of N contaminated surface- and ground waters (Kreitler, 1974; Kreitler and Browning, 1983; Heaton, 1984; Lindau and Spalding, 1984; Mariotti et al., 1988). Three main sources of NO$_3^-$-N pollution to the hydrosphere are nitrogenous fertilizers, animal wastes and soil organic matter mineralization (Heaton, 1986). These N sources can produce NO$_3^-$-N with distinguishable $^{15}$N/$^{14}$N isotopic ratios or $\delta^{15}$N (%o) values. Nitrogen fertilizers are derived from industrial

$\delta^{15}$N (%o) = ($R_{\text{sample}}/R_{\text{standard}} - 1) \times 1000$ where $R = ^{15}$N/$^{14}$N ratio and the standard is atmospheric N$_2$, with a $^{15}$N abundance of 0.3663 % (Junk and Svec, 1958).

fixation of atmospheric N\textsubscript{2} and nitrification produces NO\textsubscript{3}^-\delta^{15}N values close to zero (Shearer \textit{et al.}, 1974; Kreitler, 1979; Heaton, 1986). Nitrates produced by the oxidation of animal wastes have $\delta^{15}$N values in the range of +10 to +22\%\textsubscript{o} (Kreitler, 1974; Lindau and Spalding, 1984) and NO\textsubscript{3}^-N produced from mineralization of soil organic N has a characteristic $\delta^{15}$N range of about +4 to +9\%\textsubscript{o} (Gormly and Spalding, 1979; Mariotti, 1984). These variations in $\delta^{15}$N ranges should be used as semi-quantitative source interpretations due to the unpredictable magnitude and complexities of N stable isotope fractionations in natural systems (Hauck, 1973; Mariotti \textit{et al.}, 1988).

Very little research has been published on the use of natural variations in $^{15}$N/$^{14}$N ratios for source identification of inorganic N in surface waters (Heaton, 1986). The objectives of this note were 1) to assess the potential of natural variations of N stable isotopes for identifying sources of inorganic N and 2) determine if $^{15}$N/$^{14}$N isotopic values could be used to trace inorganic N from point source waste discharge entering Louisiana surface waters.

2. Materials and Methods

Surface water from streams and discharge from known point sources were collected

\textbf{Fig. 1.} Municipal sewage discharge and surface water sample locations (●) in the Bayou Fountain-Amite River drainage basin, Louisiana.