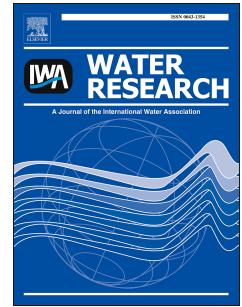


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Nitrogen sources and cycling revealed by dual isotopes of nitrate in a complex urbanized environment

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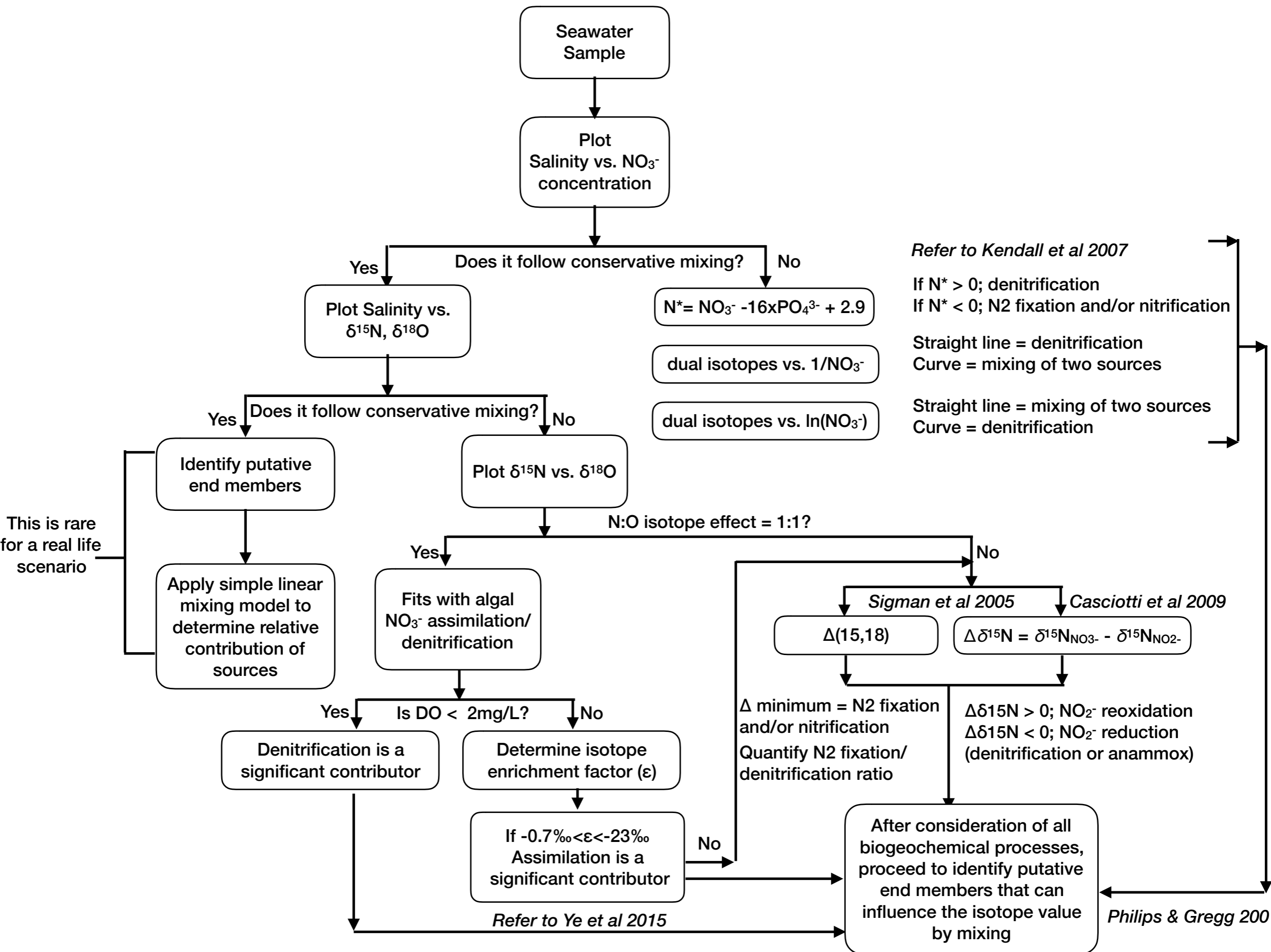
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Seawater Sample

Plot Salinity vs. NO₃⁻ concentration

Does it follow conservative mixing?

Plot Salinity vs. δ¹⁵N, δ¹⁸O

$$N^* = NO_3^- - 16 \times PO_4^{3-} + 2.9$$

dual isotopes vs. 1/NO₃⁻

dual isotopes vs. ln(NO₃⁻)

Refer to Kendall et al 2007
 If N* > 0; denitrification
 If N* < 0; N₂ fixation and/or nitrification
 Straight line = denitrification
 Curve = mixing of two sources
 Straight line = mixing of two sources
 Curve = denitrification

Does it follow conservative mixing?

Identify putative end members

Plot δ¹⁵N vs. δ¹⁸O

N:O isotope effect = 1:1?

Fits with algal NO₃⁻ assimilation/denitrification

Sigman et al 2005
 Δ(15,18)

Casciotti et al 2009
 Δδ¹⁵N = δ¹⁵N_{NO₃⁻} - δ¹⁵N_{NO₂⁻}

Is DO < 2mg/L?

Denitrification is a significant contributor

Determine isotope enrichment factor (ε)

If -0.7‰ < ε < -23‰ Assimilation is a significant contributor

Δ minimum = N₂ fixation and/or nitrification
 Quantify N₂ fixation/denitrification ratio

Δδ¹⁵N > 0; NO₂⁻ reoxidation
 Δδ¹⁵N < 0; NO₂⁻ reduction (denitrification or anammox)

After consideration of all biogeochemical processes, proceed to identify putative end members that can influence the isotope value by mixing

This is rare for a real life scenario

Apply simple linear mixing model to determine relative contribution of sources

Refer to Ye et al 2015

Philips & Gregg 2001

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