STABLE ISOTOPIQUE SIGNATURES OF NITRATE IN WASTEWATER EFFLUENT AND LOS ANGELES RIVER

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• Nitrate (NO$_3$), a nutrient originating safely from natural sources and dangerously from human activities.

• Contamination levels mainly arise from runoff, garden fertilizer, septic tanks, and sewage.
OBJECTIVES

Identify the NO3 Interplay between the LA River and WWTP's

Interpret NO3 Isotopic Signatures
Nitrification and Denitrification are applied to the wastewater primarily to manage the concentration of ammonia.

Nitrification is the process of breaking down ammonia contaminants into nitrite though the use of ammonia-oxidizing bacteria.

\[
\text{NH}_3 + \text{O}_2 \rightarrow \text{NO}_2^- + 3\text{H}^+ + 2\text{e}^-
\]

Next, a similar technique is used by utilizing a nitrite-oxidizing bacteria to oxidize the produced nitrite into nitrate

\[
\text{NO}_2^- + \text{H}_2\text{O} \rightarrow \text{NO}_3^- + 2\text{H}^+ + 2\text{e}^-
\]

Denitrification extends this process by adding a step that reduces nitrate into nitrogen gas by using facultative anaerobes such as fungi.

\[
6 \text{NO}_3^- + 2 \text{CH}_3\text{OH} \rightarrow 6 \text{NO}_2^- + 2 \text{CO}_2 + 4 \text{H}_2\text{O}
\]

\[
6 \text{NO}_2^- + 3 \text{CH}_3\text{OH} \rightarrow 3 \text{N}_2 + 3 \text{CO}_2 + 3 \text{H}_2\text{O} + 6 \text{OH}^-
\]
Study Area

5 Sampling Locations

3 Isotope Sample Locations

3 Wastewater Treatment Plants
Research indicates that in naturally occurring nitrate, only one oxygen atom is sourced from atmospheric O₂, while the other two originate from water, which tends to be significantly depleted in δ¹⁸O.

This stands in contrast to nitrate found in synthetic fertilizers, where the oxygen is primarily derived from atmospheric O₂ and will resultingly be less depleted, and possibly enriched.
### Nitrate Data

#### Nitrate Fluctuations Between Locations

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Distance (km/miles)</th>
<th>2012 Dry Season NO\textsubscript{3}-N (mg/l)</th>
<th>2013 Wet Season NO\textsubscript{3}-N (mg/l)</th>
<th>2017 Dry Season NO\textsubscript{3}-N (mg/l)</th>
<th>2018 Wet Season NO\textsubscript{3}-N (mg/l)</th>
<th>2022 Dry Season NO\textsubscript{3}-N (mg/l)</th>
<th>2023 Wet Season NO\textsubscript{3}-N (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>0</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>4.36</td>
<td>2.56</td>
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<tr>
<td>Tillman WWTP</td>
<td>5.07 (3.2)</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>4.54</td>
<td>3.55</td>
</tr>
<tr>
<td>Sepulveda Basin</td>
<td>6.25 (3.9)</td>
<td>3.8</td>
<td>3.86</td>
<td>4.04</td>
<td>4.2</td>
<td>6.17</td>
<td>3.3</td>
</tr>
<tr>
<td>Glendale Narrows</td>
<td>35.77 (22.2)</td>
<td>4.86</td>
<td>1.63</td>
<td>4.2</td>
<td>2.78</td>
<td>4.34</td>
<td>3.2</td>
</tr>
<tr>
<td>Arroyo Seco</td>
<td>44.52 (27.7)</td>
<td>4.16</td>
<td>2.53</td>
<td>3.68</td>
<td>1.3</td>
<td>4.77</td>
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<td>Average</td>
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<td>4.27</td>
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<tr>
<td>STDEV</td>
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<tr>
<td>MIN</td>
<td></td>
<td>3.8</td>
<td>1.63</td>
<td>3.68</td>
<td>1.3</td>
<td>4.34</td>
<td>2.56</td>
</tr>
<tr>
<td>MEDIAN</td>
<td></td>
<td>4.16</td>
<td>2.53</td>
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<td></td>
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<td>3.86</td>
<td>4.2</td>
<td>4.2</td>
<td>6.17</td>
<td>3.55</td>
</tr>
</tbody>
</table>

#### Nitrate Fluctuations Graph

- **Orange Line**: Dry Season
- **Blue Line**: Wet Season

- **Sample Locations**: Upstream, Tillman WWTP, Sepulveda Basin, Glendale Narrows, Arroyo Seco C.

- **Nitrate Concentration**: 0 to 7 mg/L
Hypothesis

- **H₁**: There is a significant impact of pH on Nitrate concentration.
- **H₂**: There is a significant impact of Salinity on Nitrate concentration.
- **H₃**: There is a significant impact of water Temperature on Nitrate concentration.
- **H₄**: There is a significant historical impact of water temperature on Nitrate concentration from data measured in 2012-2013, 2017-2018, and 2022-2023.
TEMPERATURE AND NITRATE

2022-2023

NO3-N (mg/l)

0 5 10 15 20 25 30

Water Temperature °C

2012-2023

NO3-N (mg/l)

0 5 10 15 20 25 30

Water Temperature °C

NO3-N

Predicted NO3-N

NO3-N (mg/L)

2012-2023

Percent Land Area

U.S. Drought Monitor California

D4 D3 D2 D1 D0


Upstream
Tillman WWTP
Sepulveda Basin
Glendale Narrows
Arroyo Seco
CONCLUSIONS AND LIMITATIONS

• Nitrate signatures show more natural influence in treated water.

• Nitrate concentrations are correlated to Water temperature.

• Dry Seasons have higher NO3 concentrations than Wet Seasons.

- Only two sets of samples from a single WWTP has been investigated.

- Most studies support a link between NO3 and temperature.

- California has distinct dry and wet seasons as well as frequent and severe droughts.