Nitrogen Dynamics in a Suburban Coastal Watershed

Effects of Population Density, Land Use and Soil Characteristics

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Research Questions?

1. Do landscape characteristics drive nitrogen dynamics in stream water? **YES**
2. Do landscape characteristics drive nitrogen dynamics in groundwater?
3. Does stream water chemistry mimic groundwater chemistry?
4. What are the biogeochemical transformations along flow paths?
Lamprey River Hydrologic Observatory

Focus of teaching and research efforts within several departments at UNH
Connecticut River Airshed Watershed Consortium (CRAWC)
CRAWC Objectives

1. Develop the infrastructure of the Lamprey River Hydrologic Observatory
2. Develop regression models that link groundwater quality to landscape characteristics
   • Land use
   • Population density
   • Soil characteristics (C storage, N storage and C:N ratios)
3. Compare groundwater chemistry to stream water chemistry
4. Document biogeochemical transformations along flow paths
   • Denitrification
   • Adsorption of Dissolved Organic Nitrogen
   • Microbial Uptake
5. Test regression models on the Connecticut River
Objective 1 - Develop the infrastructure of the Lamprey River Hydrologic Observatory
Land Use

Land Use:
- Agriculture
- Cleared/Open
- Forested
- Urban
- Water
- Wetlands
Population Density

People per km²:
- 0
- 0 - 124 (Rural)
- 125 - 620 (Suburban)
- > 620 (Urban)

United States Census 2000
Lamprey Soil Series
Precipitation Collectors
Precipitation Gauges
Wells and Stream Gauges
Objective 2 - Develop regression models that link groundwater quality to landscape characteristics

- Select sub-basins
- Characterize sub-basins in a GIS
- Sample and analyze groundwater
- Develop regression relationships
Lamprey Sub-basin Sites
## Land Use

<table>
<thead>
<tr>
<th>Sub-basin Characteristic</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (km(^2))</td>
<td>1.3</td>
<td>23.5</td>
</tr>
<tr>
<td>Population Density (people km(^{-2}))</td>
<td>18.8</td>
<td>157.3</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.1%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Cleared/Open</td>
<td>1.1%</td>
<td>11.6%</td>
</tr>
<tr>
<td>Forested</td>
<td>52.1%</td>
<td>85.9%</td>
</tr>
<tr>
<td>Urban</td>
<td>0.3%</td>
<td>21.0%</td>
</tr>
<tr>
<td>Water</td>
<td>0.0%</td>
<td>10.1%</td>
</tr>
<tr>
<td>Wetlands</td>
<td>4.8%</td>
<td>20.8%</td>
</tr>
</tbody>
</table>
Homeowner Well Sampling

NH DES Homeowner Well Metadata

[Map showing the distribution of wells with labels and scale]
Sample Analysis

- Dissolved Organic Carbon (DOC)
- Dissolved Organic Nitrogen (DON)
- Nitrate
- Ammonium
- Phosphate

Arsenic
Developing actual groundwater regression models cannot be done until well sampling and analysis is complete

*However*

Surface water regression models provide the initial framework to characterize controls on groundwater chemistry
Nitrate vs. Population Density

Global Model
\[ y = 0.64 x - 0.84 \]
\[ r^2 = 0.53 \]
\[ p < 0.00001 \]
(Peierls et al., 1991)

Lamprey
\[ y = 1.41x - 2.78 \]
\[ r^2 = 0.78 \]
\[ p < 0.001 \]
(Daley and McDowell, in review)
$y = 0.042 x - 0.371$

$r^2 = 0.743$

$p < 0.001$

DON vs. Wetland Cover

(Daley and McDowell, in review)
DOC vs. Wetlands
(Daley et al., in review)

\[ y = 2.35x + 3.44 \]
\[ r^2 = 0.814 \]
\[ p < 0.001 \]
Objective 3 - Compare groundwater chemistry to stream water chemistry
Objective 4 - Document transformations along flow paths
In stream Nitrogen

NO3-N
\[ y = 0.140x - 41.5 \]
\[ r^2 = 0.76 \]
\[ p < 0.001 \]

NH4-N
\[ y = -1.08x + 1507 \]
\[ r^2 = 0.94 \]
\[ p < 0.001 \]
Objective 5 - Test regression models on the Connecticut River

NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION

Connecticut River Nitrogen Project
Questions?
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  http://www.ctraws.org/
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