

Spatial and Temporal Variability of Nutrients and Sediment in Urban Streams

Claire Welty

UMBC

Center for Urban Environmental Research and Education

and

Dept. of Chemical, Biochemical and Environmental Engineering

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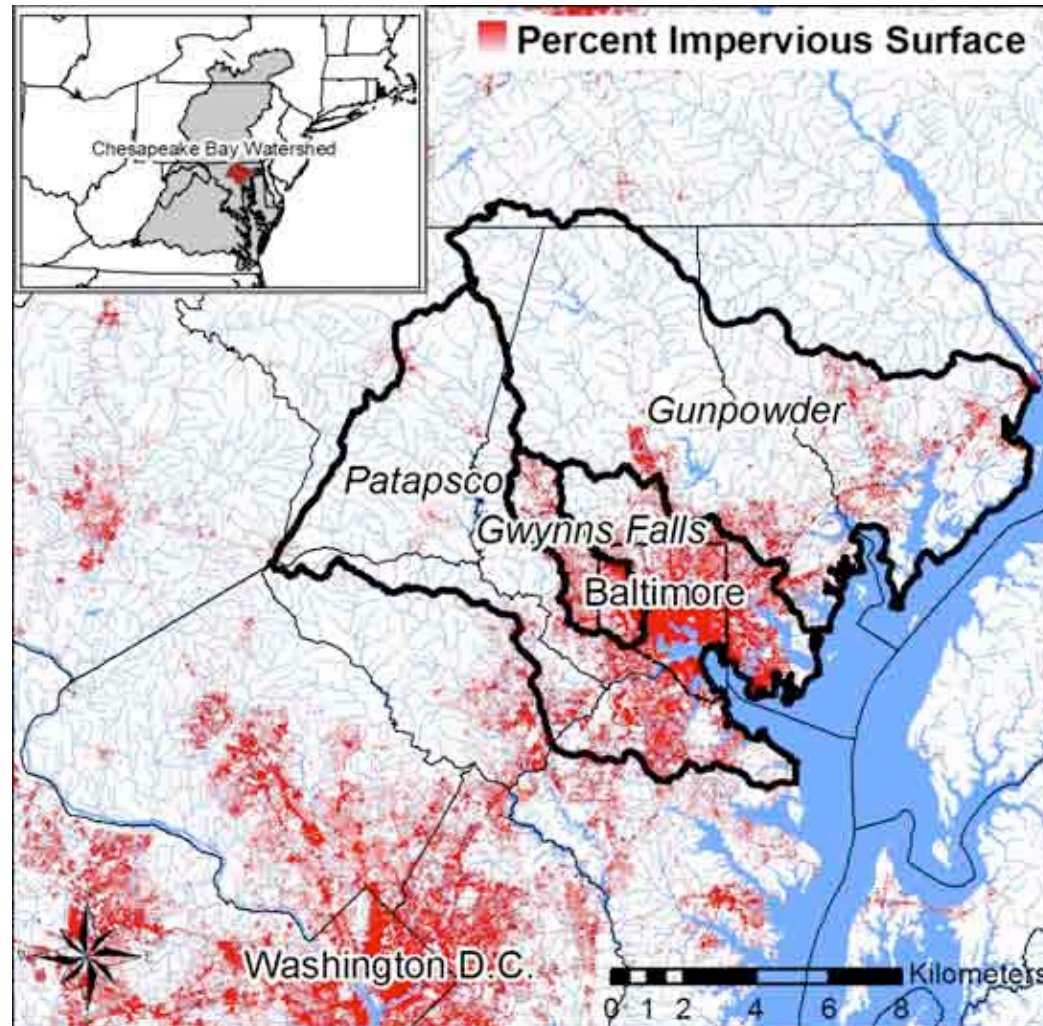


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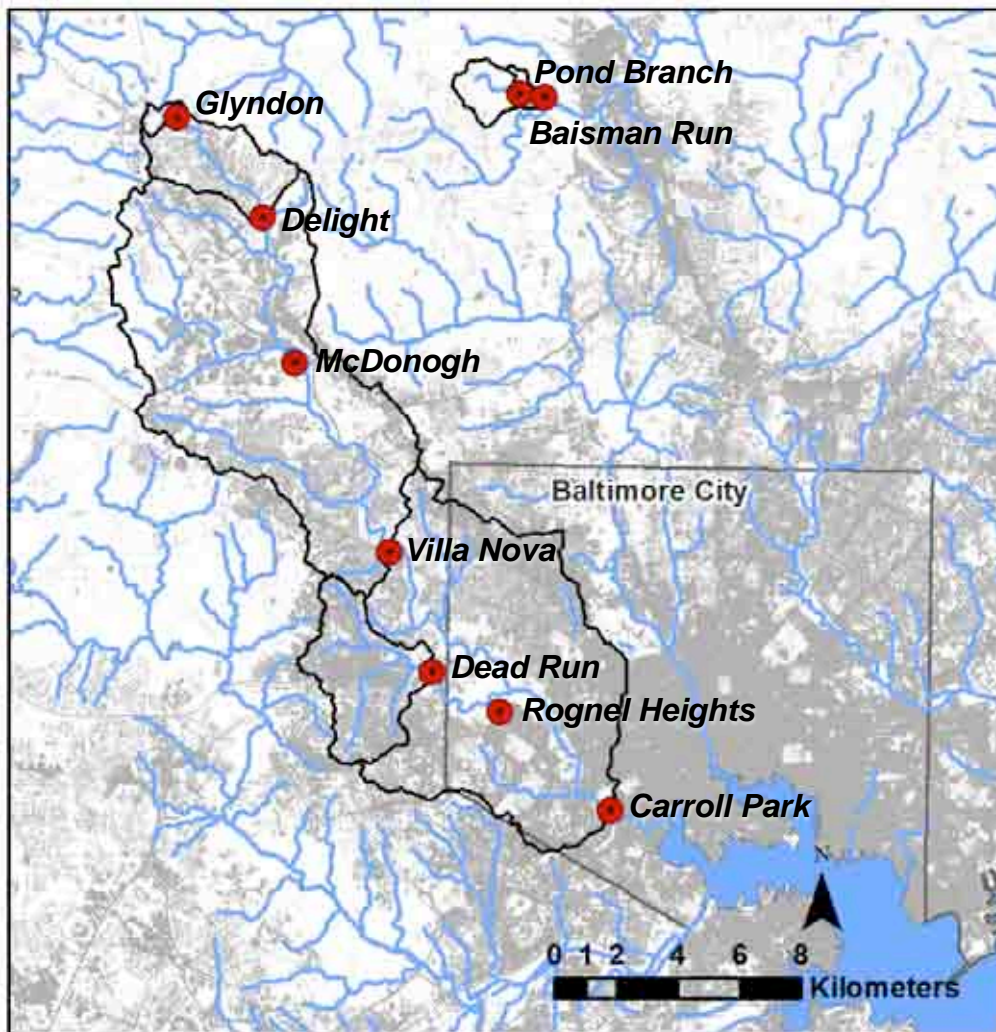


USGS
science for a changing world

Baltimore Ecosystem Study Long-Term Ecological Research Project



Gwynns Falls Watershed



171 sq km

Urban to rural gradient
of land cover

Forested & agricultural
reference sites

9 USGS stream gages

Nested watershed design

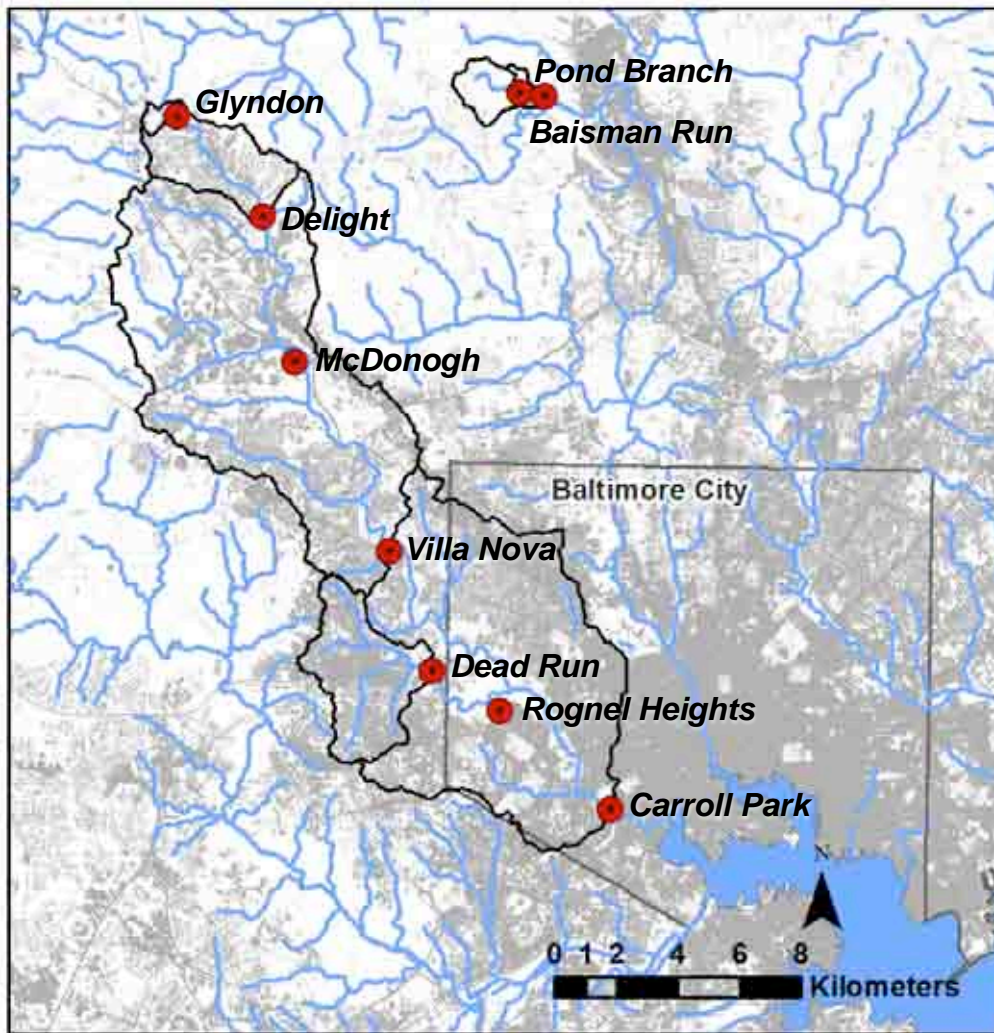
Weekly chemistry

sampling since 1998

NO_3^- , PO_4^{3-} , SO_4^{2-} , Cl^-

Total N, Total P

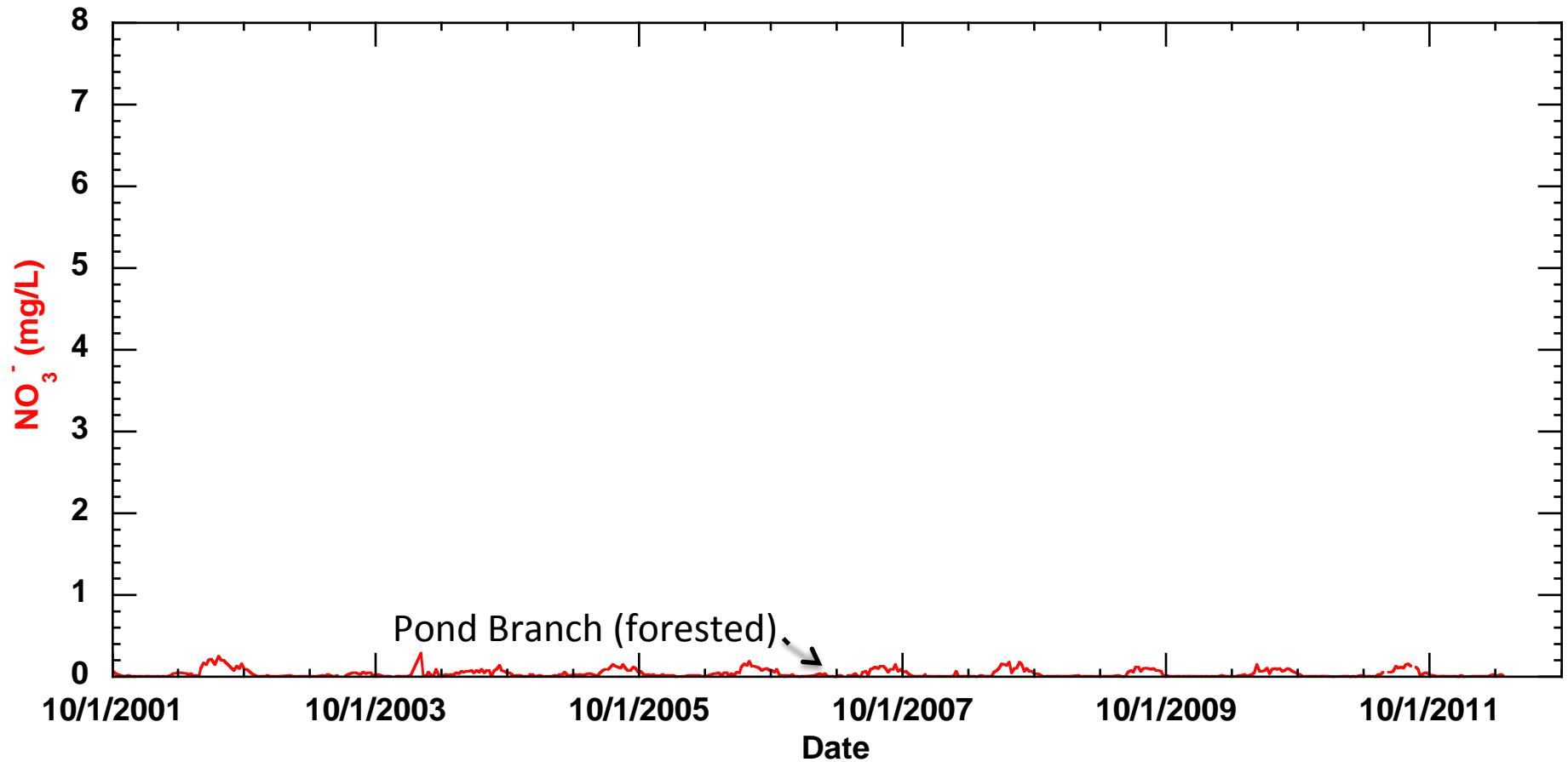
Gwynns Falls Watershed



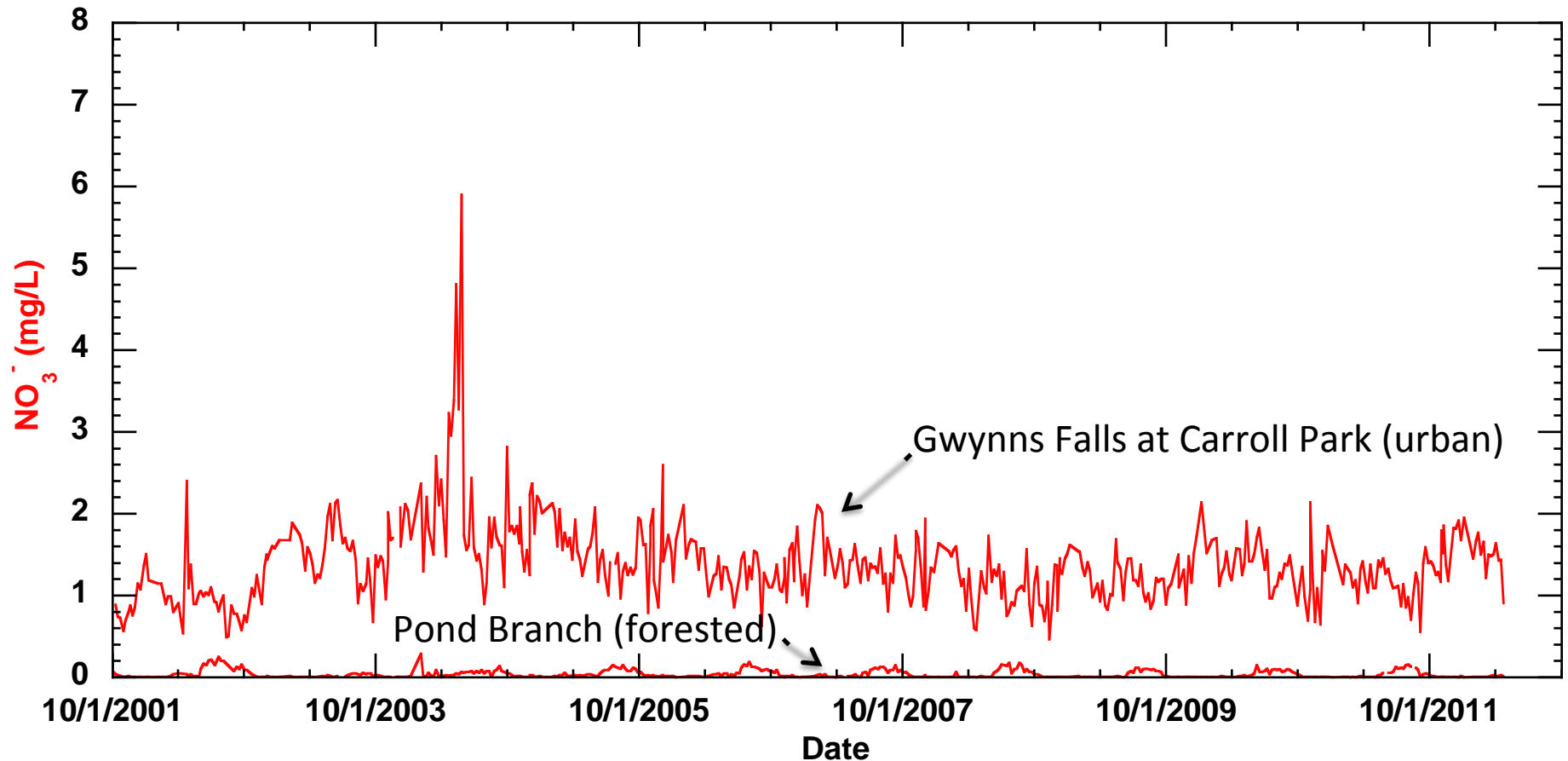
| Watershed | Area (km ²) | Percent Impervious |
|------------------------------|-------------------------|--------------------|
| Pond Branch (forest) | 0.4 | 0 |
| Baisman Run (forest/exurban) | 3.8 | 5 |
| Glyndon | 0.7 | 21.1 |
| Delight | 10.6 | 18.6 |
| Villa Nova | 84.5 | 21.1 |
| Carroll Park | 171 | 30.3 |
| Dead Run (urban) | 14.1 | 45 |
| McDonogh (agriculture) | 0.06 | 0 |

Data available for download from beslter.org

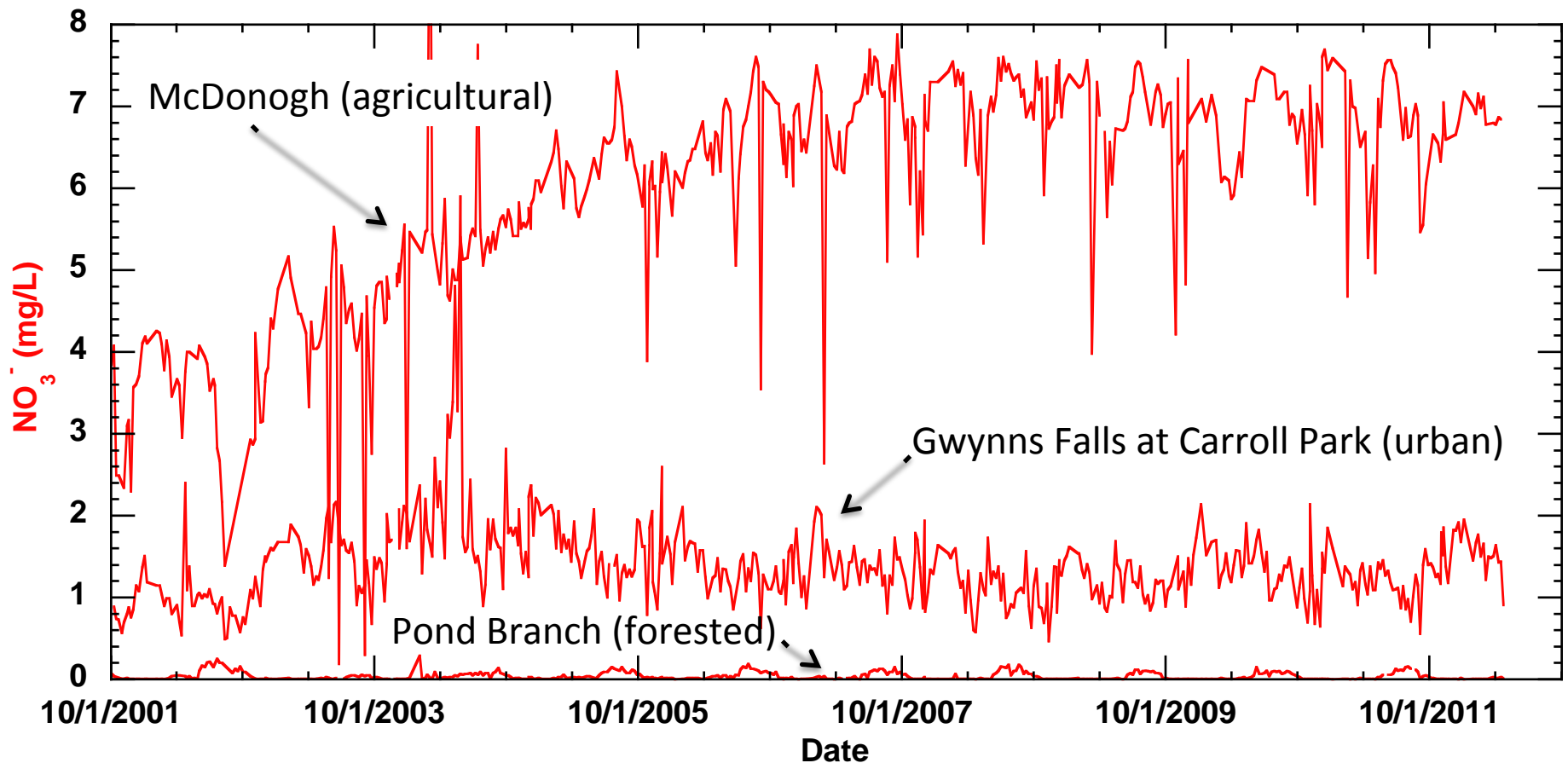
BES weekly data – example nitrate concentration time series



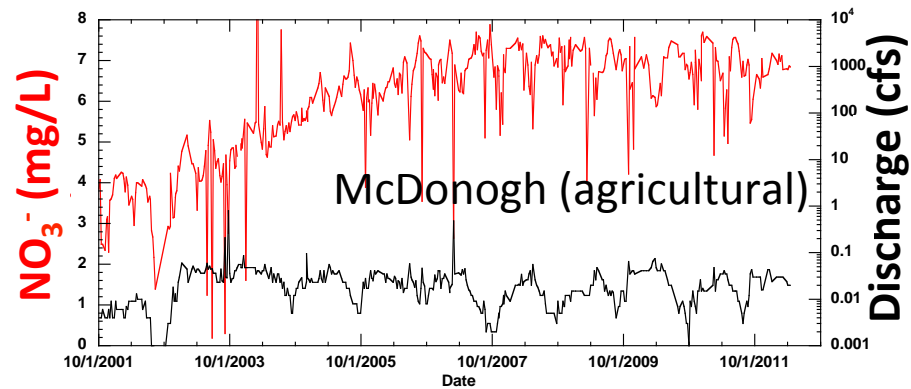
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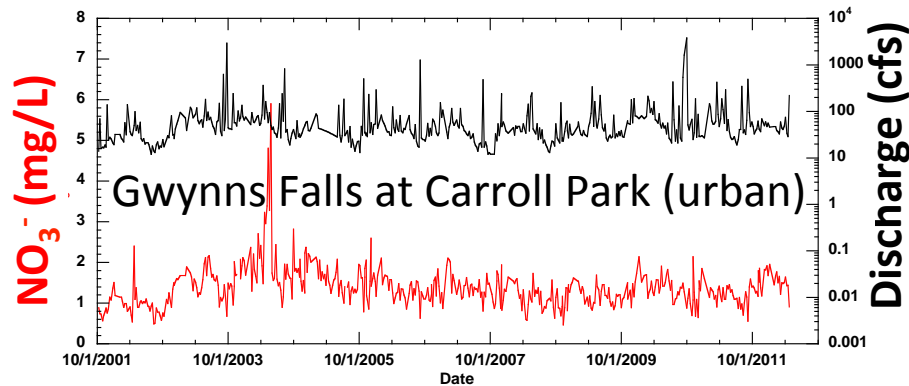
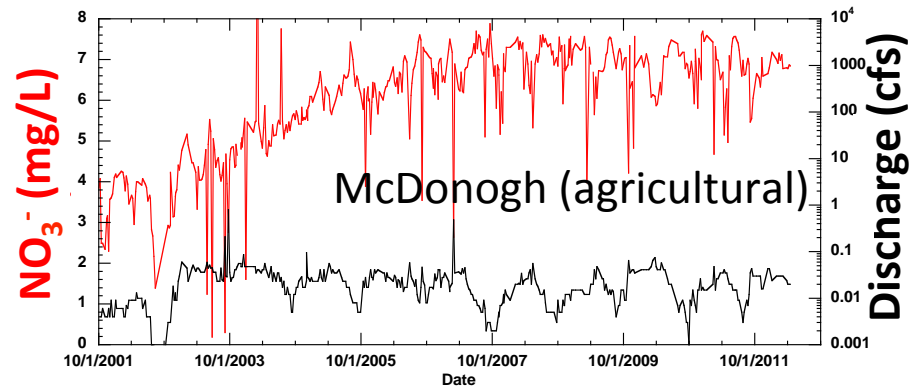
BES weekly data – example nitrate concentration time series



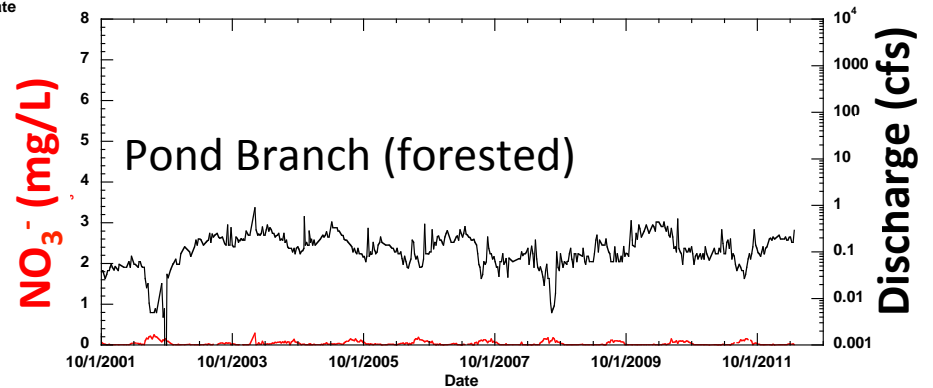
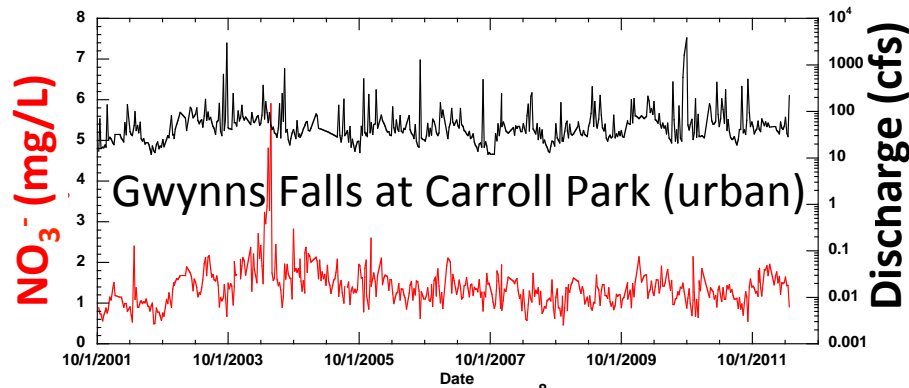
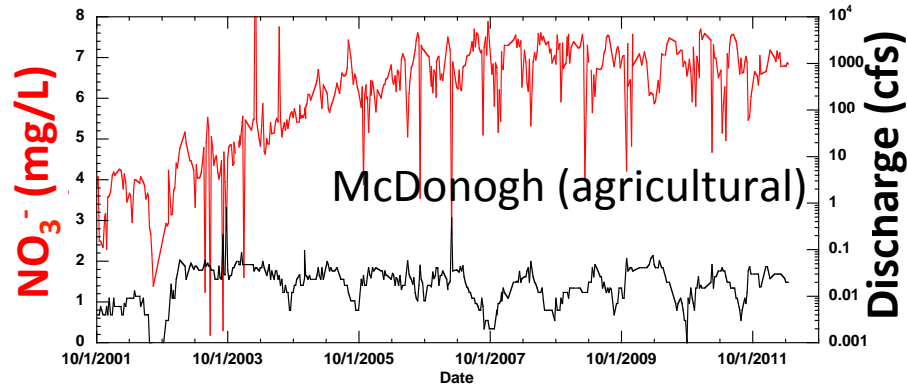
BES weekly Data – nitrate + discharge time series



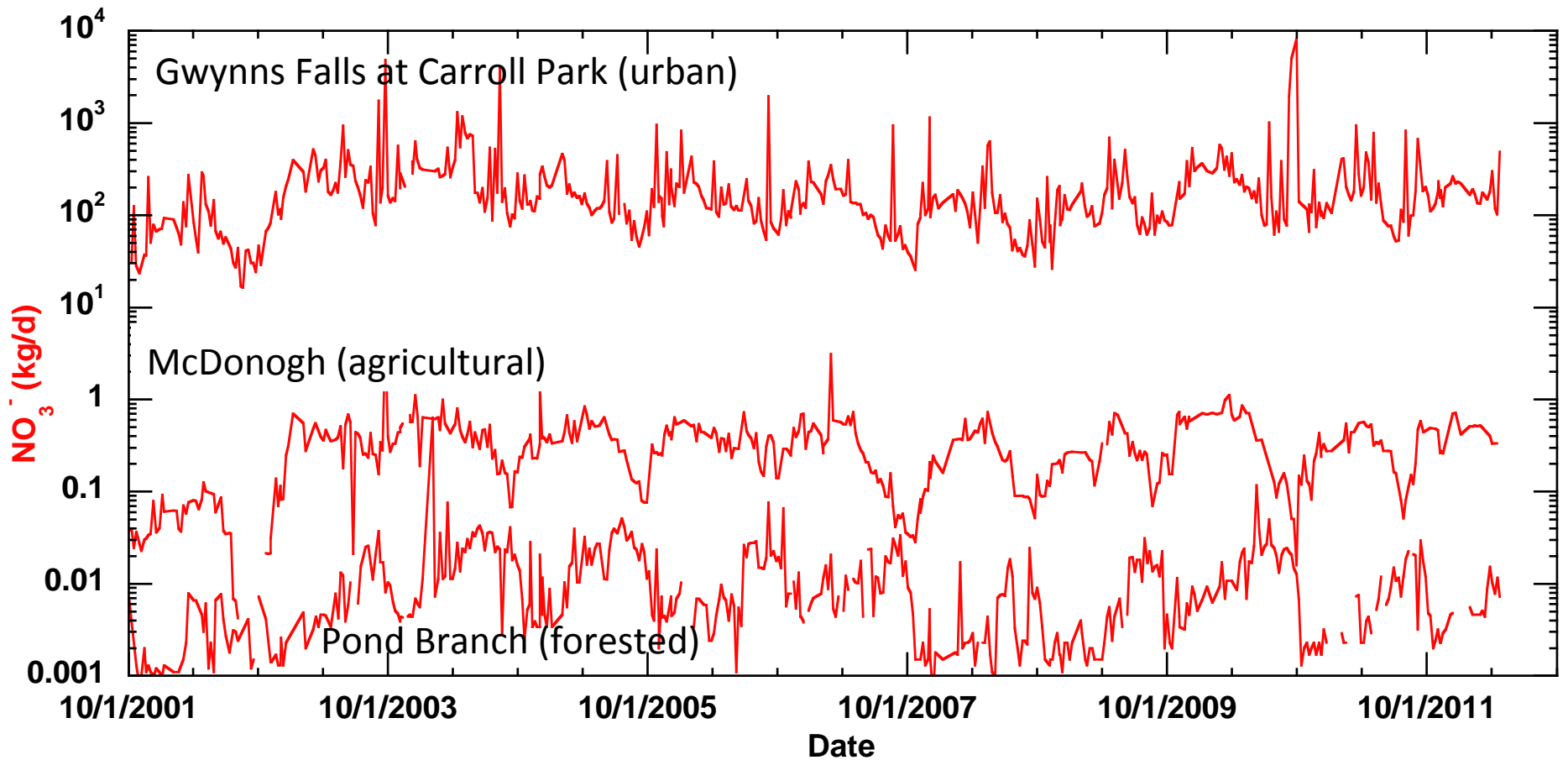
BES weekly data – nitrate + discharge time series



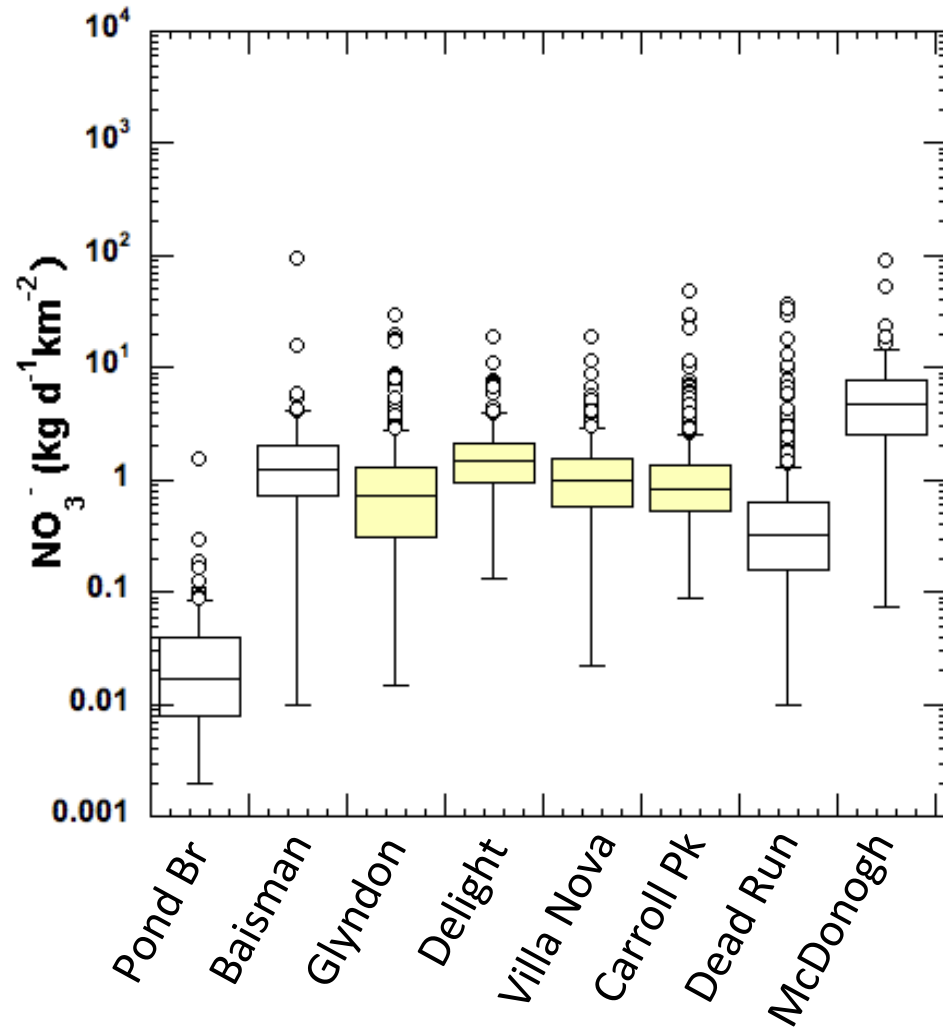
BES weekly data – nitrate + discharge time series



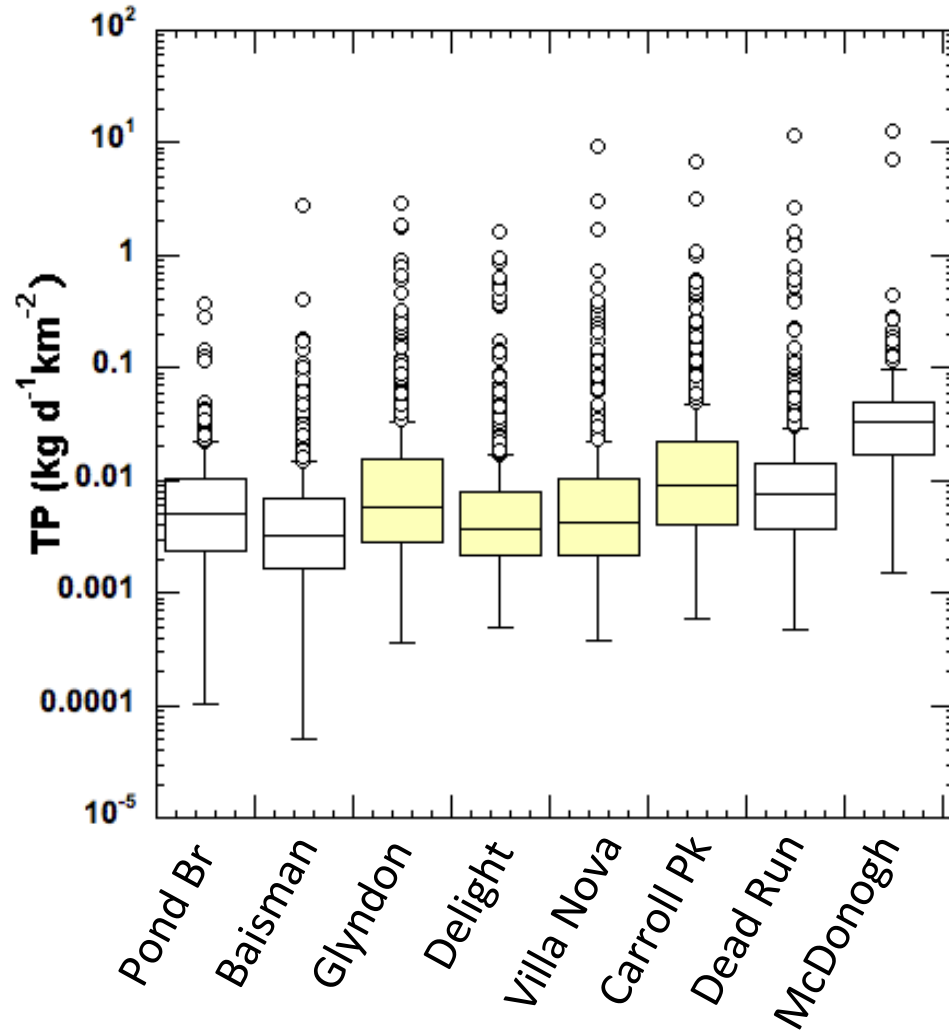
BES weekly data – nitrate daily loads



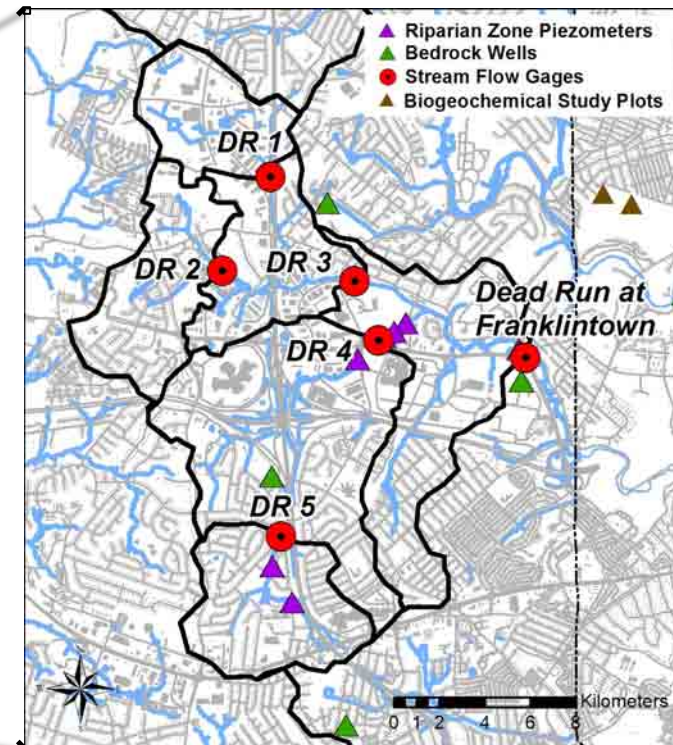
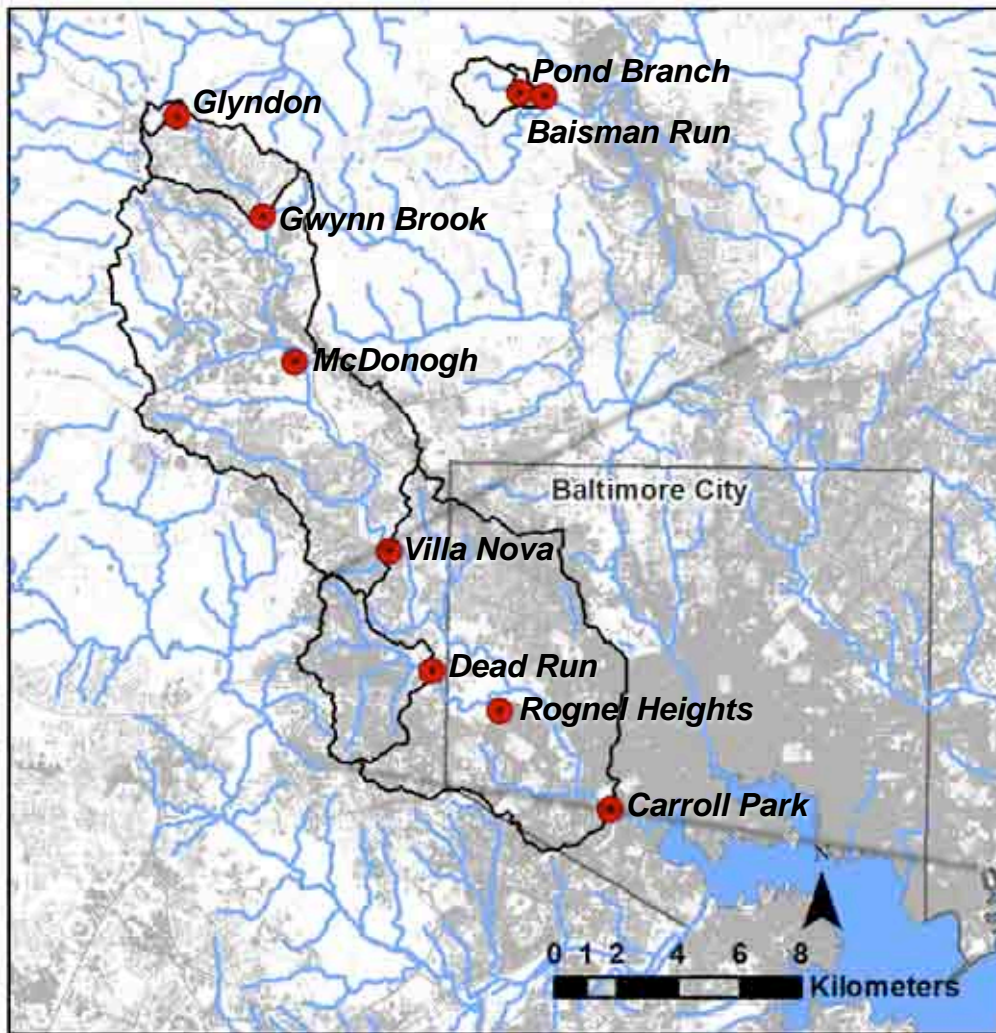
BES weekly data – nitrate yields



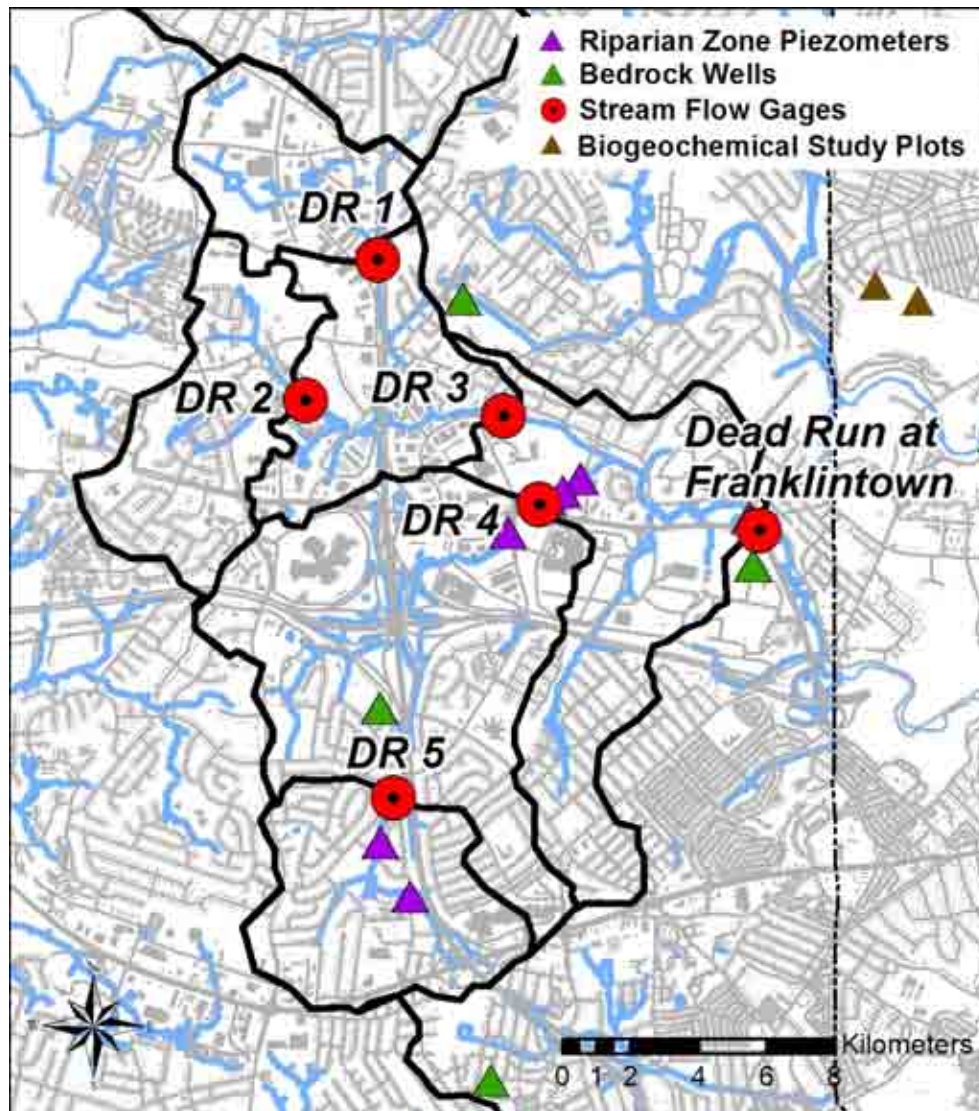
BES weekly data – TP yields



Dead Run Watershed



Dead Run Watershed



14.1 sq km

45% impervious cover

6 USGS stream gages

Nested watershed design

High-frequency sensors

deployed since 2010

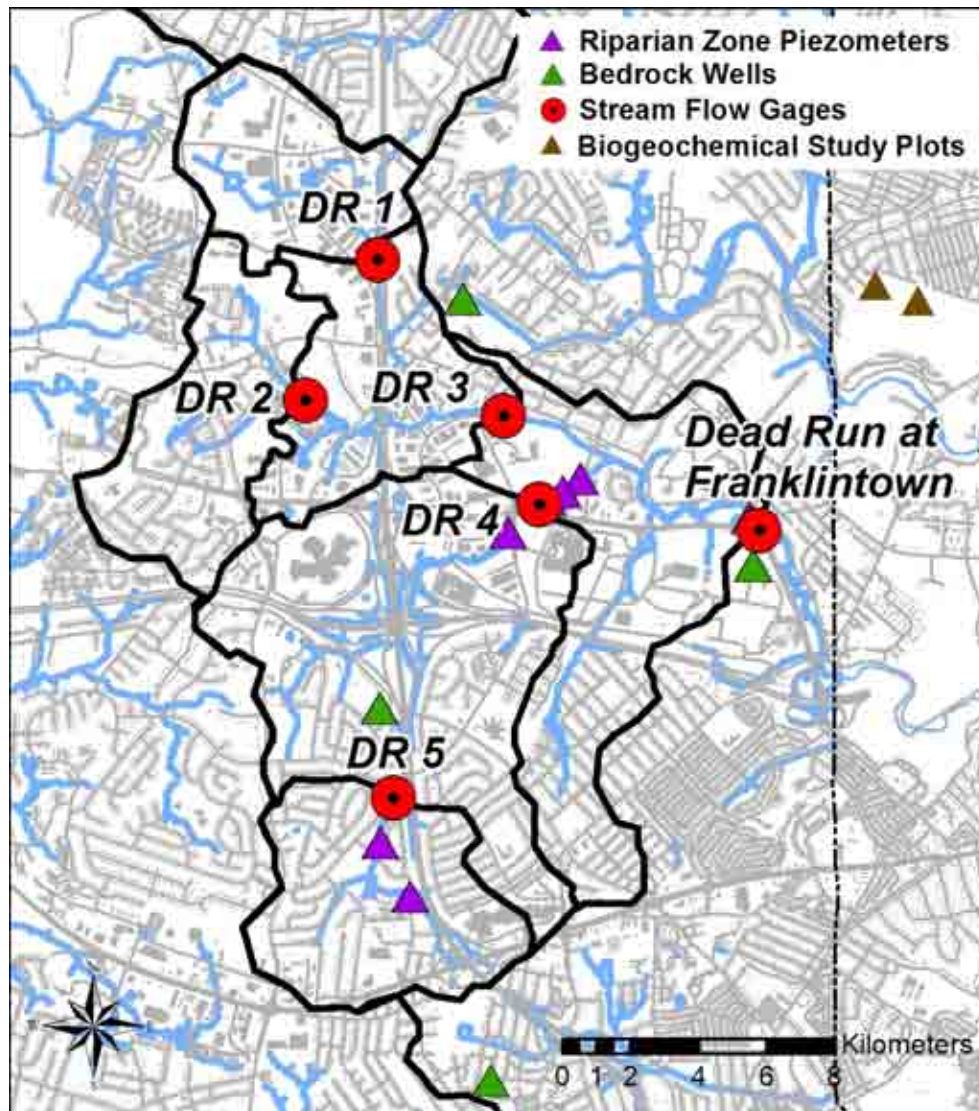
30-minute sampling

NO_3^- (Satlantic SUNA)

SC, temperature, DO,

turbidity (YSI EXO2)

Dead Run Watershed



| Watershed | Area (km ²) | Percent Impervious |
|----------------|-------------------------|--------------------|
| DR1 | 1.3 | 51 |
| DR2 | 1.9 | 45 |
| DR5 | 1.5 | 45 |
| DR3 | 5.0 | 48 |
| DR4 | 6.2 | 50 |
| DR Franklinton | 14.1 | 45 |

Satlantic SUNA



- Submersible Ultraviolet Nitrate Analyzer
- Ultraviolet absorption spectroscopy
- In-situ measurement of nitrate N
- Detection range: 0.007 to 28 mg/L as N
- Precision: 0.028 mg/L as N
- Accuracy: ~ +/- 10% of reading
- Cost per unit: ~\$22K (without peripherals)

YSI EXO2



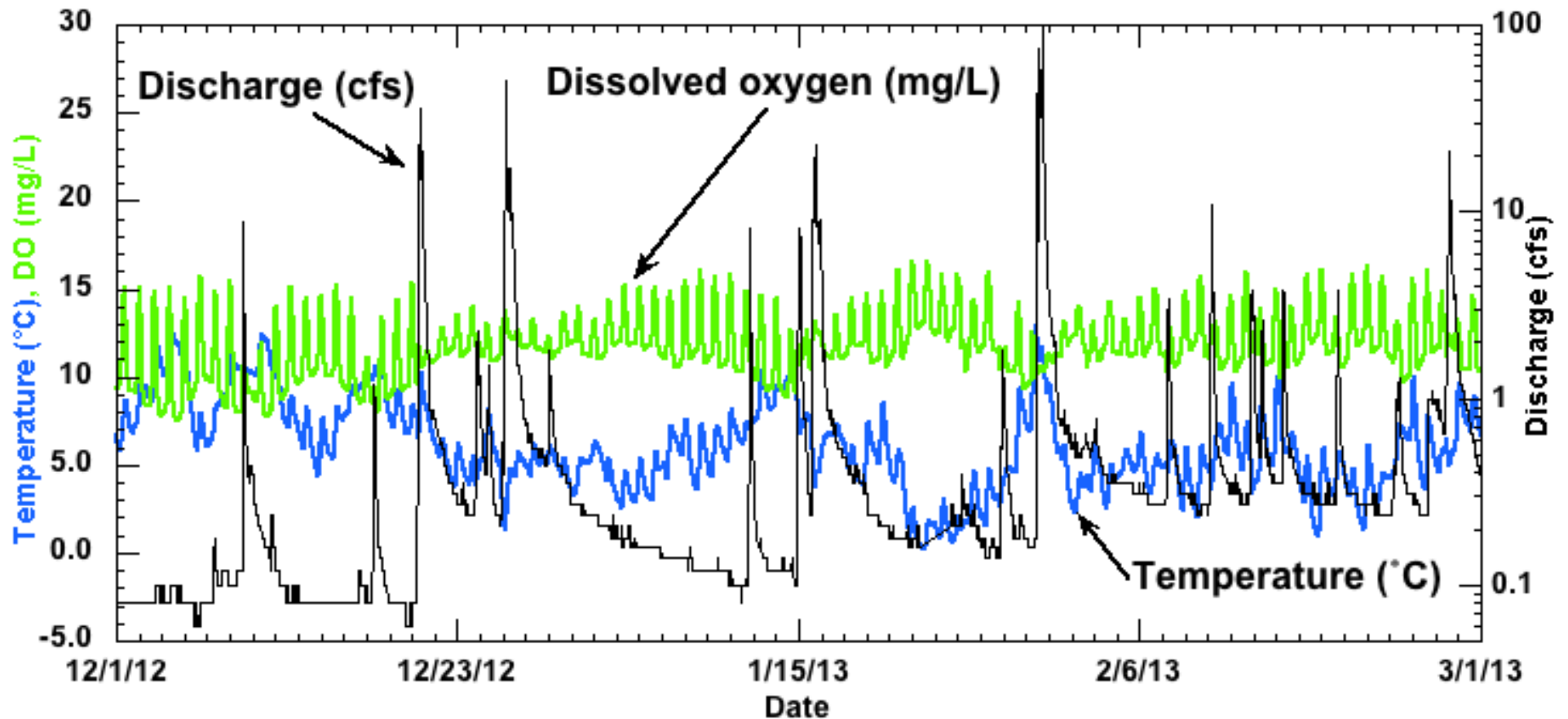
- Sonde with 7 ports for WQ sensors
- In-situ measurement of temperature, specific conductance, dissolved oxygen, turbidity
- Optical turbidity sensor: Nephelometric near-IR turbidimeter
- Detection Range: 0 to 4000 FNU (formazin nephelometric units)
- Precision: 0.01 FNU
- Accuracy: 0.3 FNU or $\pm 2\%$ of reading
- Cost per unit: \sim \$10K (without peripherals)





Example data from one site (DR1)

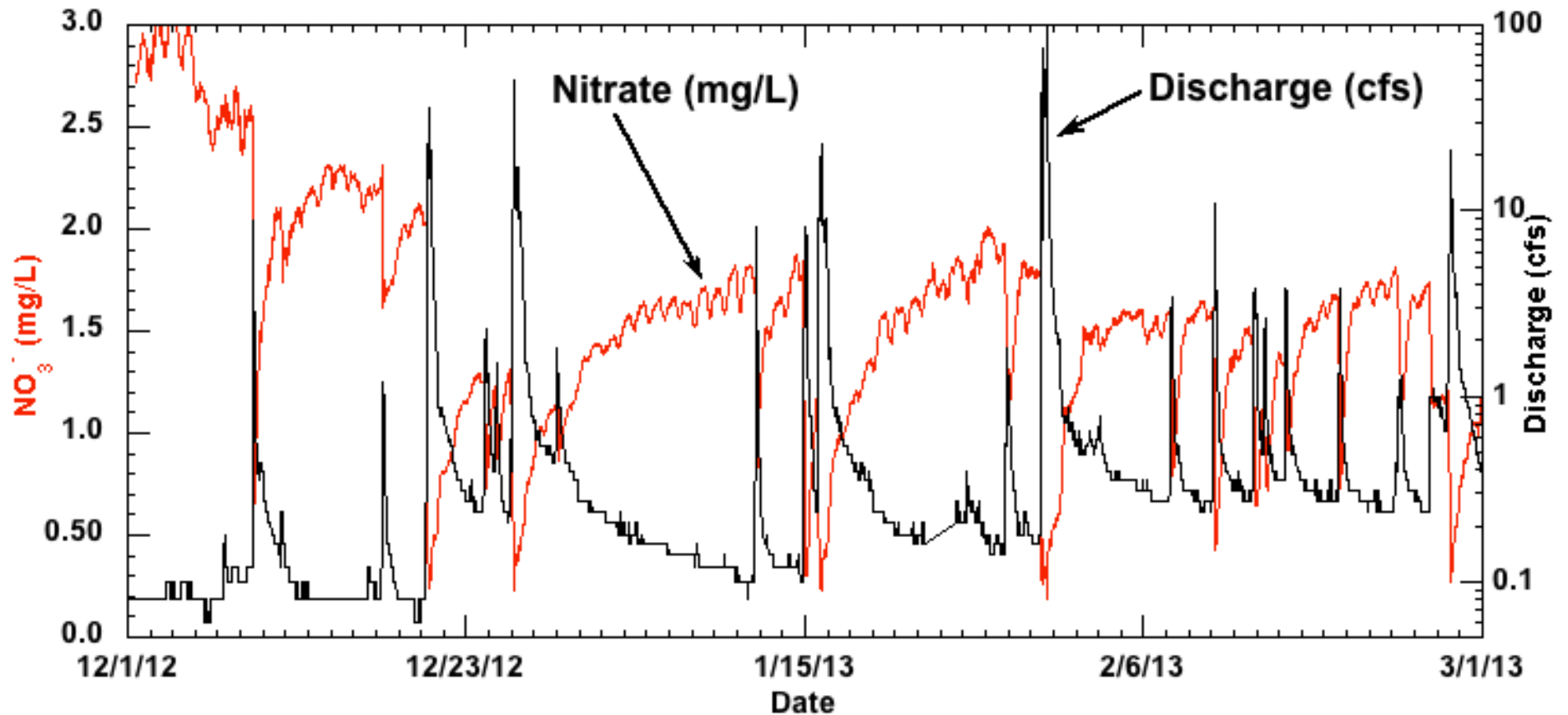
Discharge, DO, and temperature



Discharge: http://waterdata.usgs.gov/md/nwis/uv?site_no=01589317

Water quality: C. Welty, unpublished data

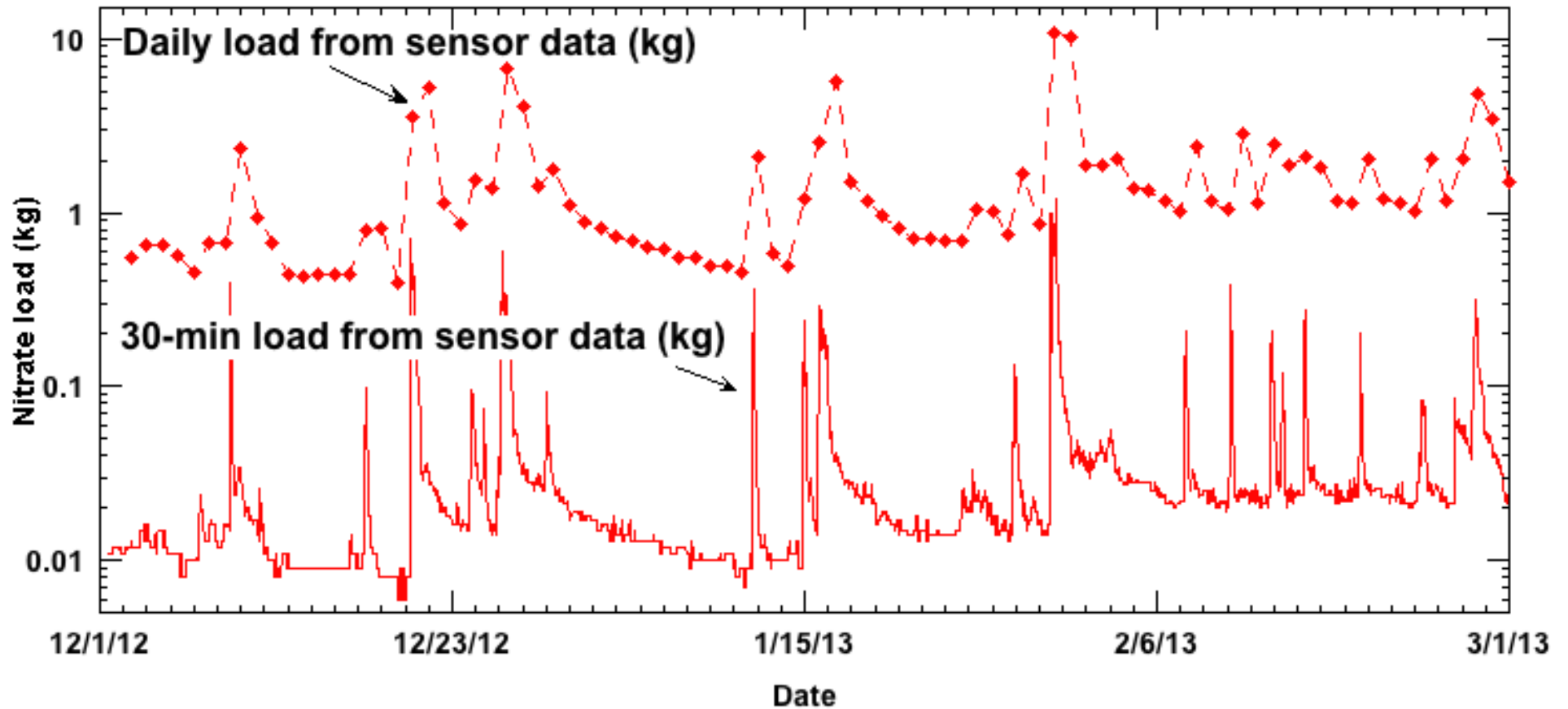
Nitrate and discharge



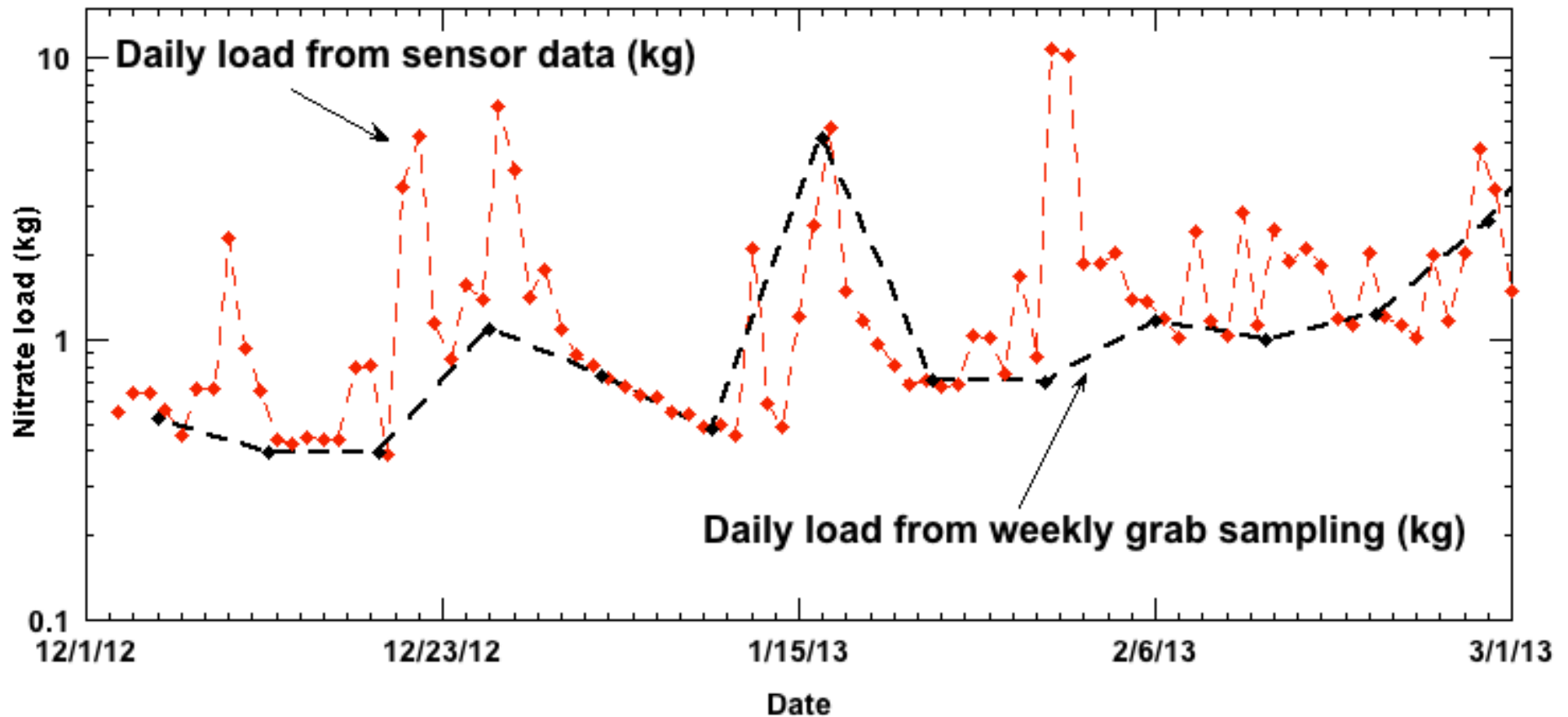
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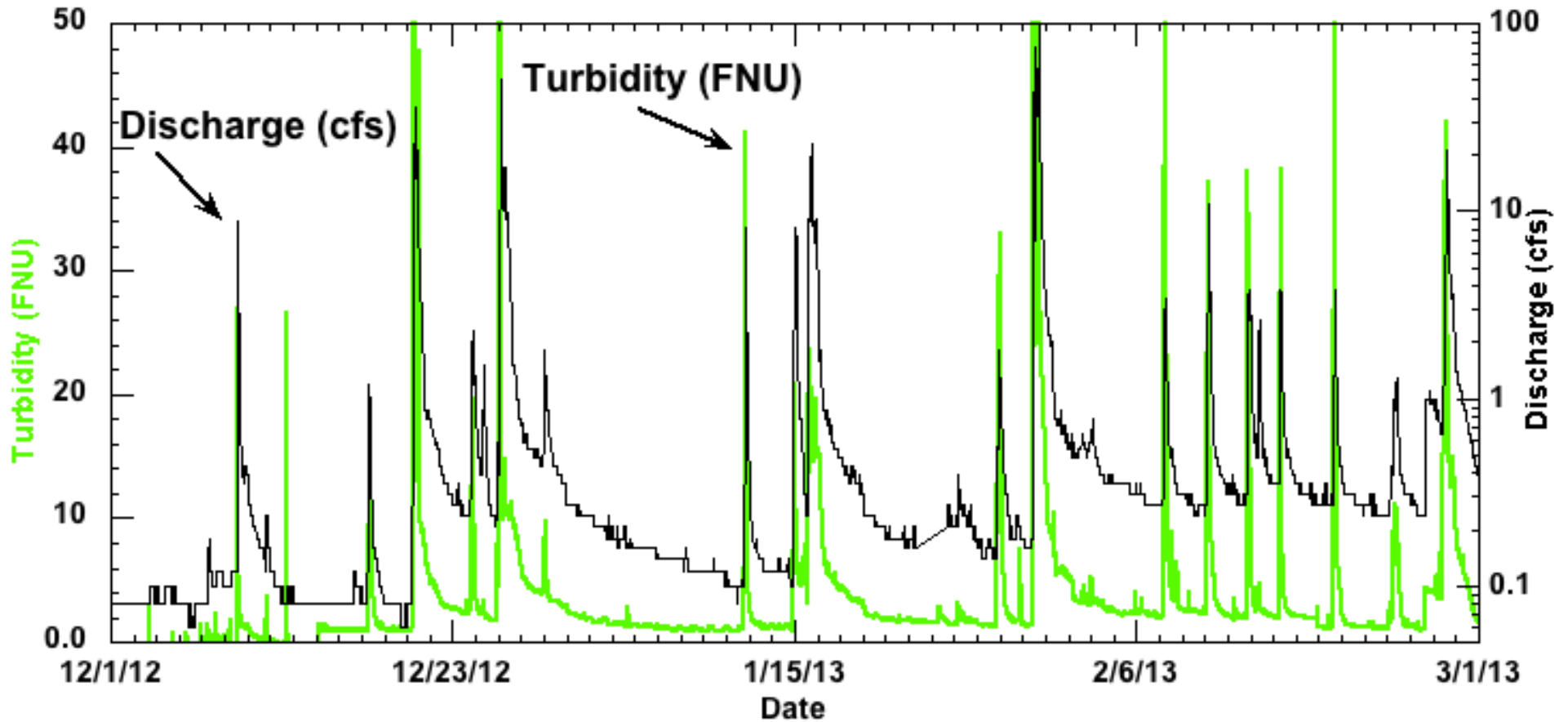
Nitrate load calculations



Nitrate load calculations



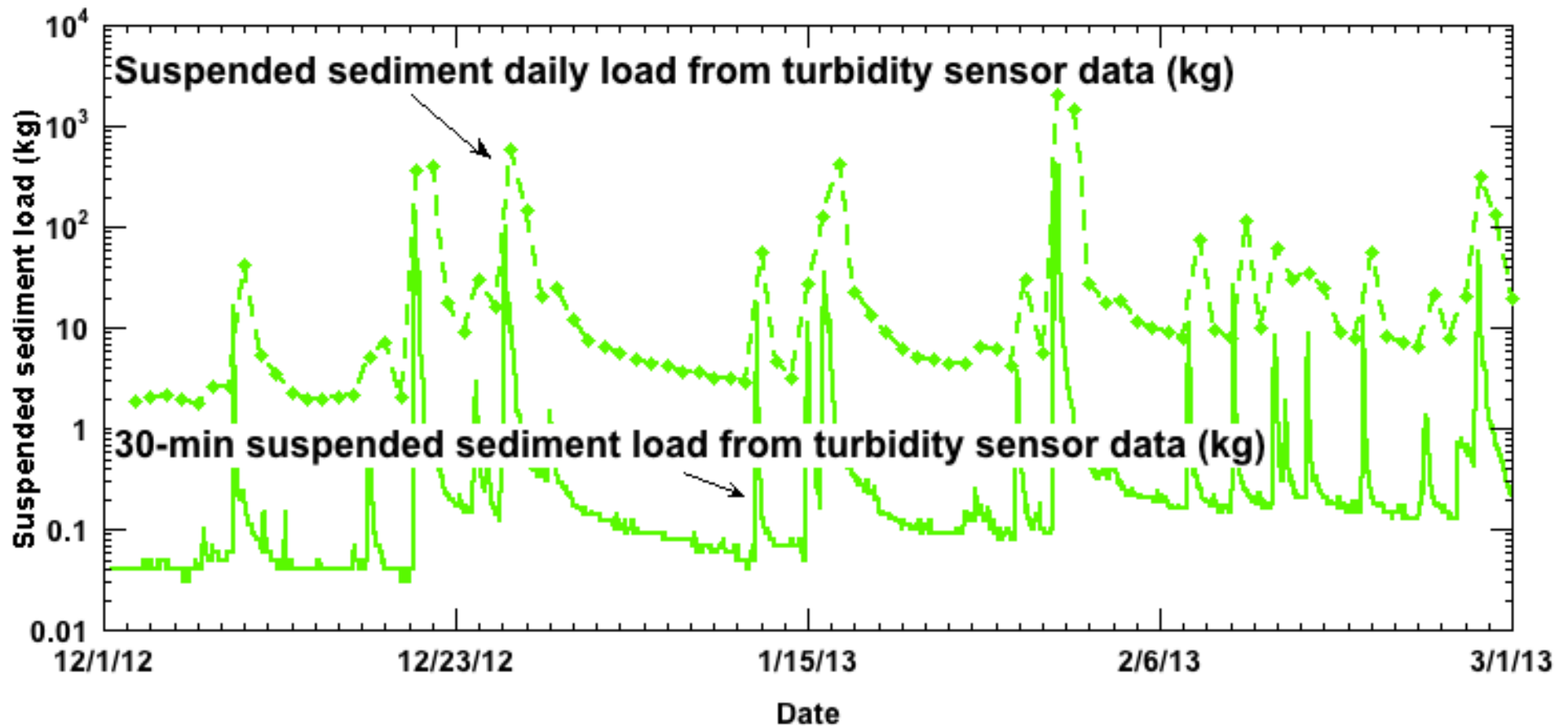
Turbidity and discharge



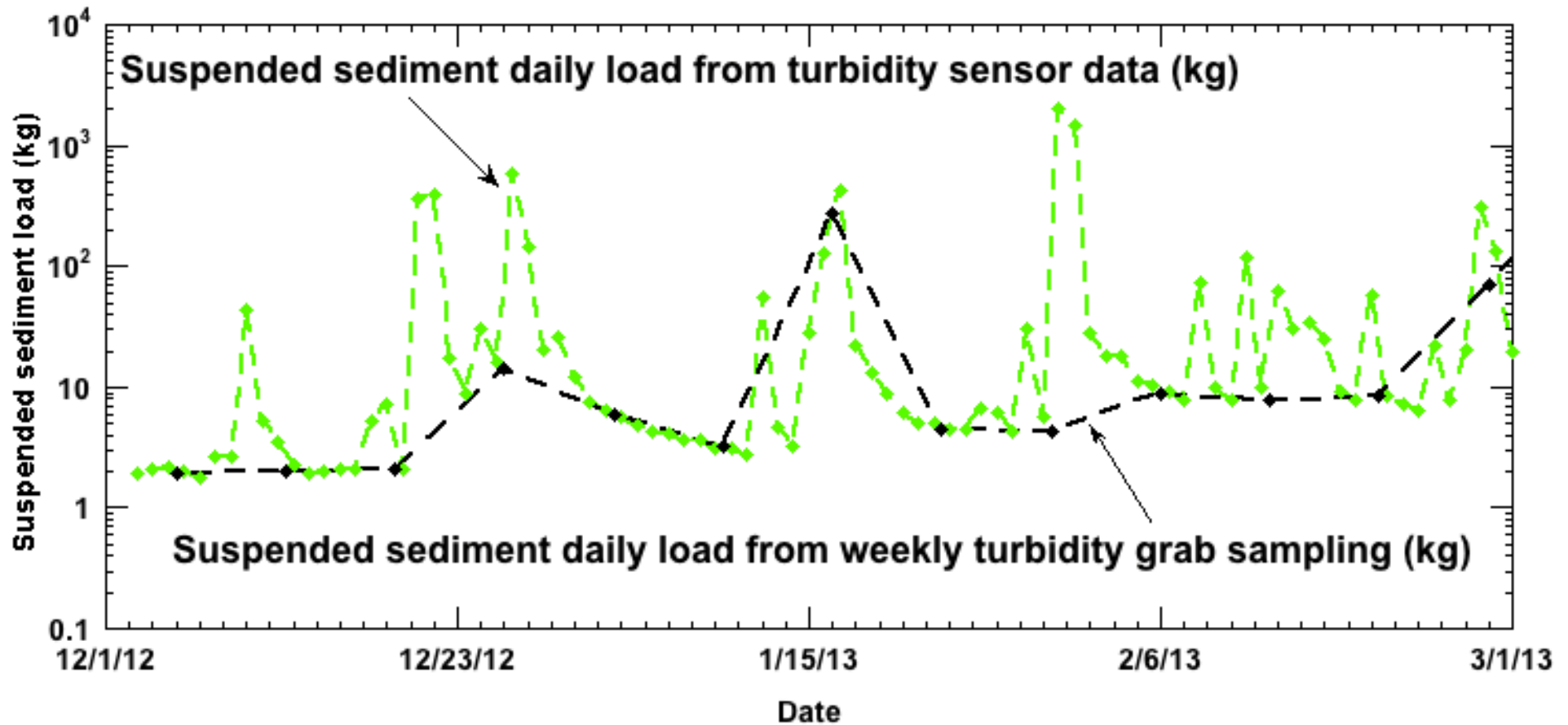
Discharge: http://waterdata.usgs.gov/md/nwis/uv?site_no=01589317

Water quality: C. Welty, unpublished data

Suspended sediment load calculations

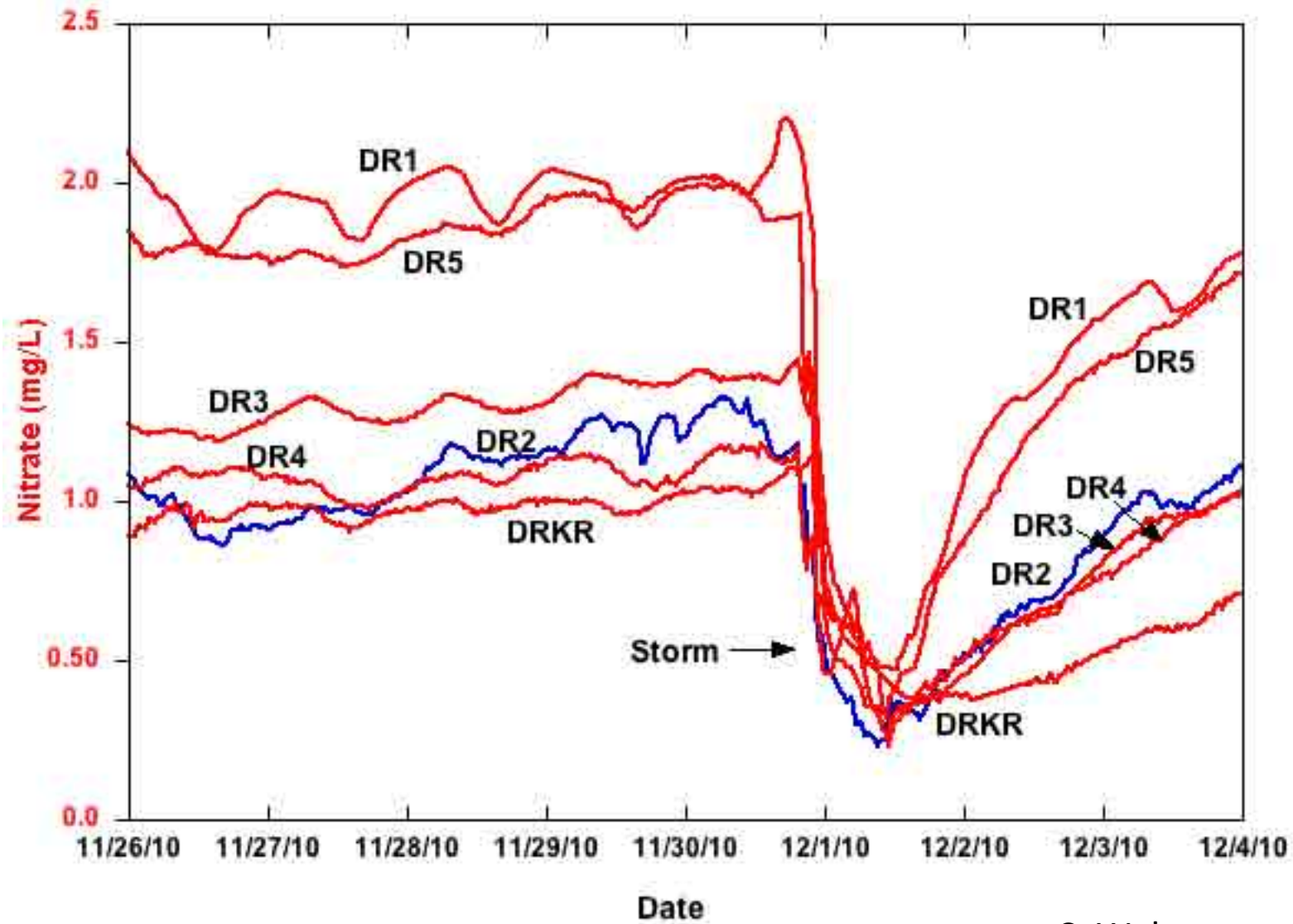


Suspended sediment load calculations



Example data from across sites

Nitrate



C. Welty, unpublished data

Ongoing and future urban work

- Detecting effects of BMPs at the watershed scale
- Improved quantification of groundwater-surface water interactions
- Upscaling processes from point/plot measurements to stream reach and watershed scale
- Other constituents – chloride, pharmaceuticals, toxics
- Integration of modeling and observations at fine grid scales

Acknowledgements

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