Understanding water quality trends in urban watersheds

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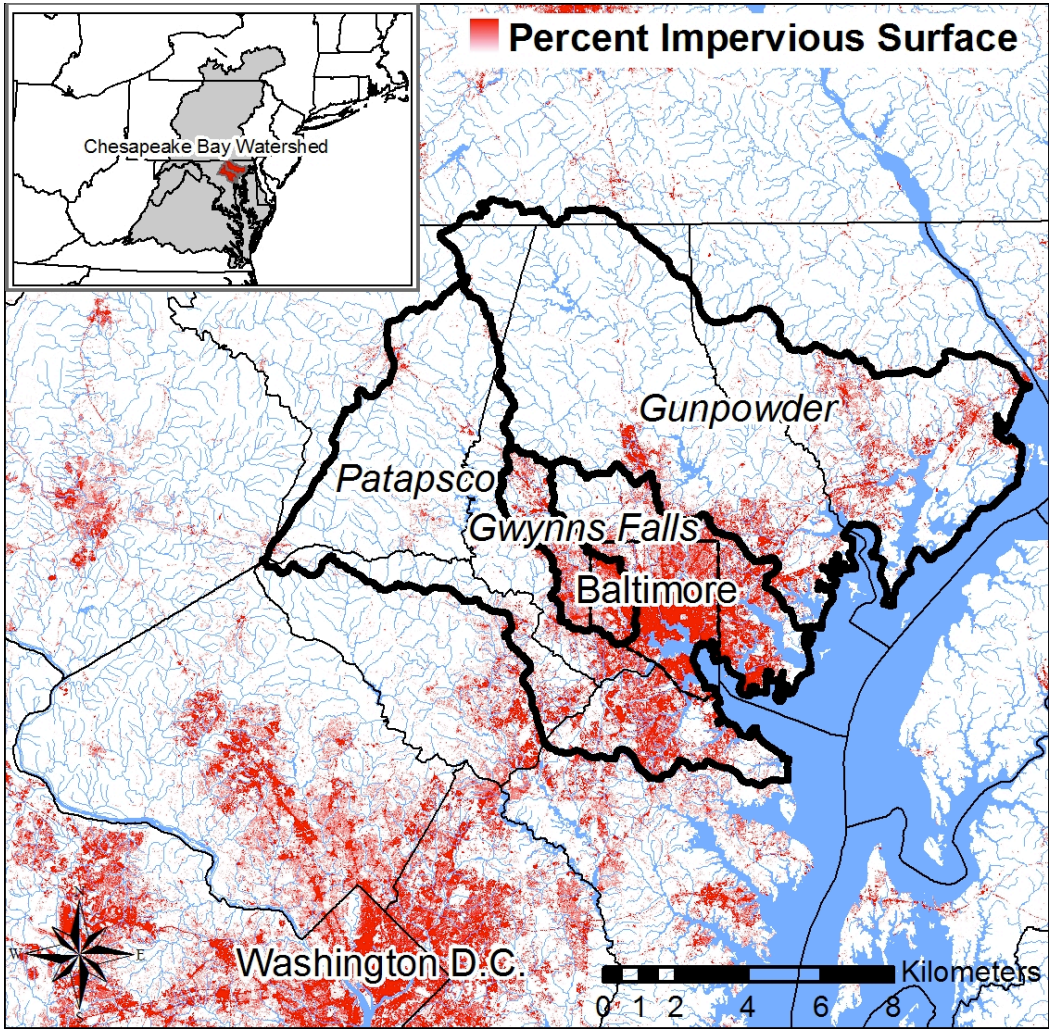
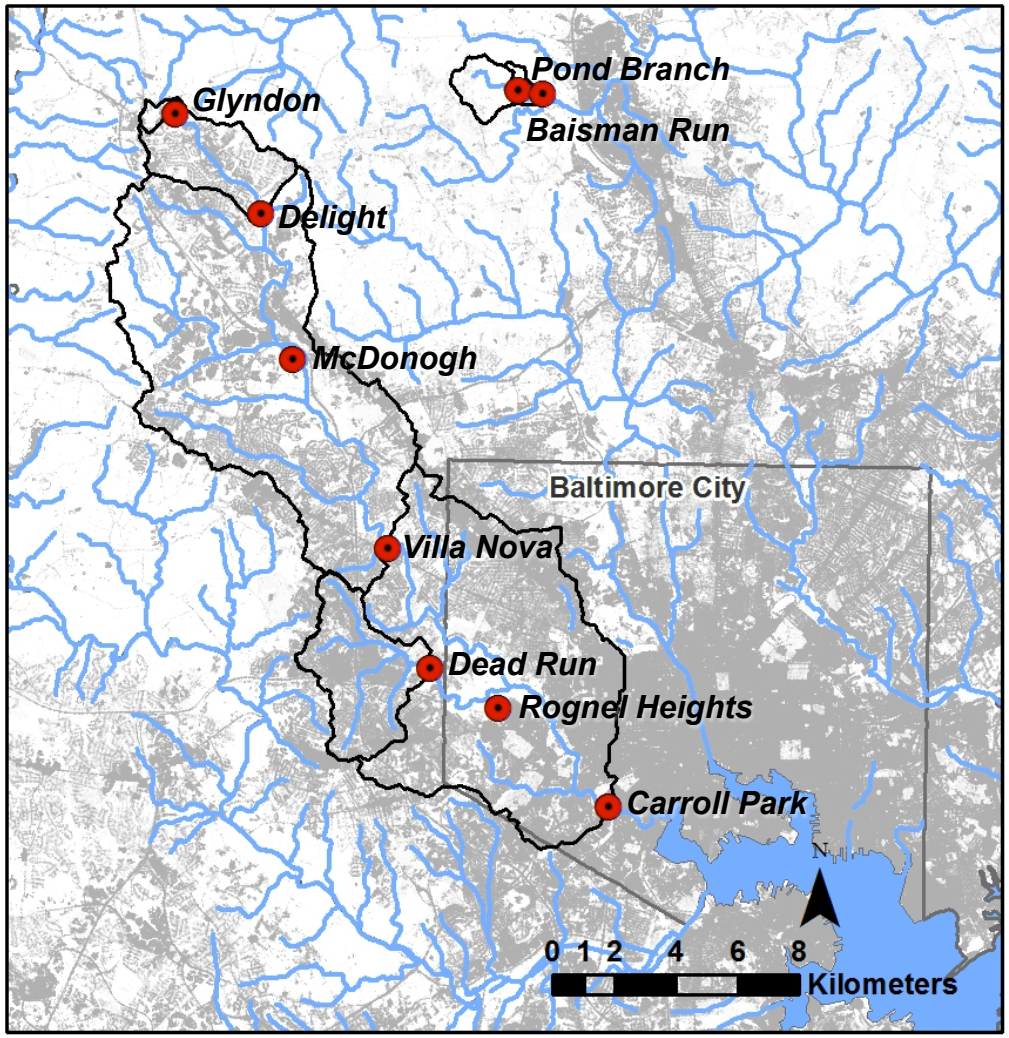
Baltimore Ecosystem Study
Long-Term Ecological Research Project



Gwynns Falls Watershed



171 sq km

Urban to rural gradient of land cover

Forested & agricultural reference sites

9 USGS stream gages

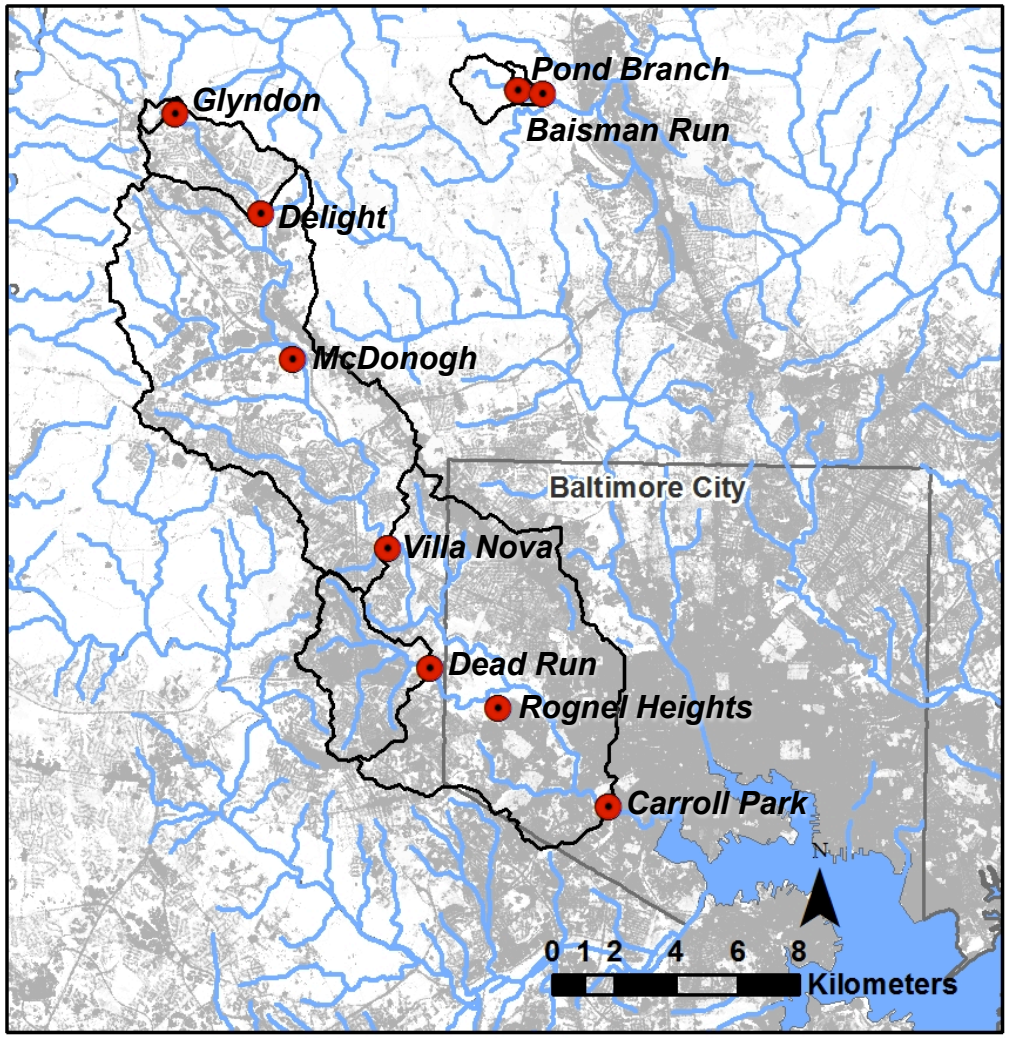
Nested watershed design

Weekly chemistry sampling since 1998

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

Total N, Total P

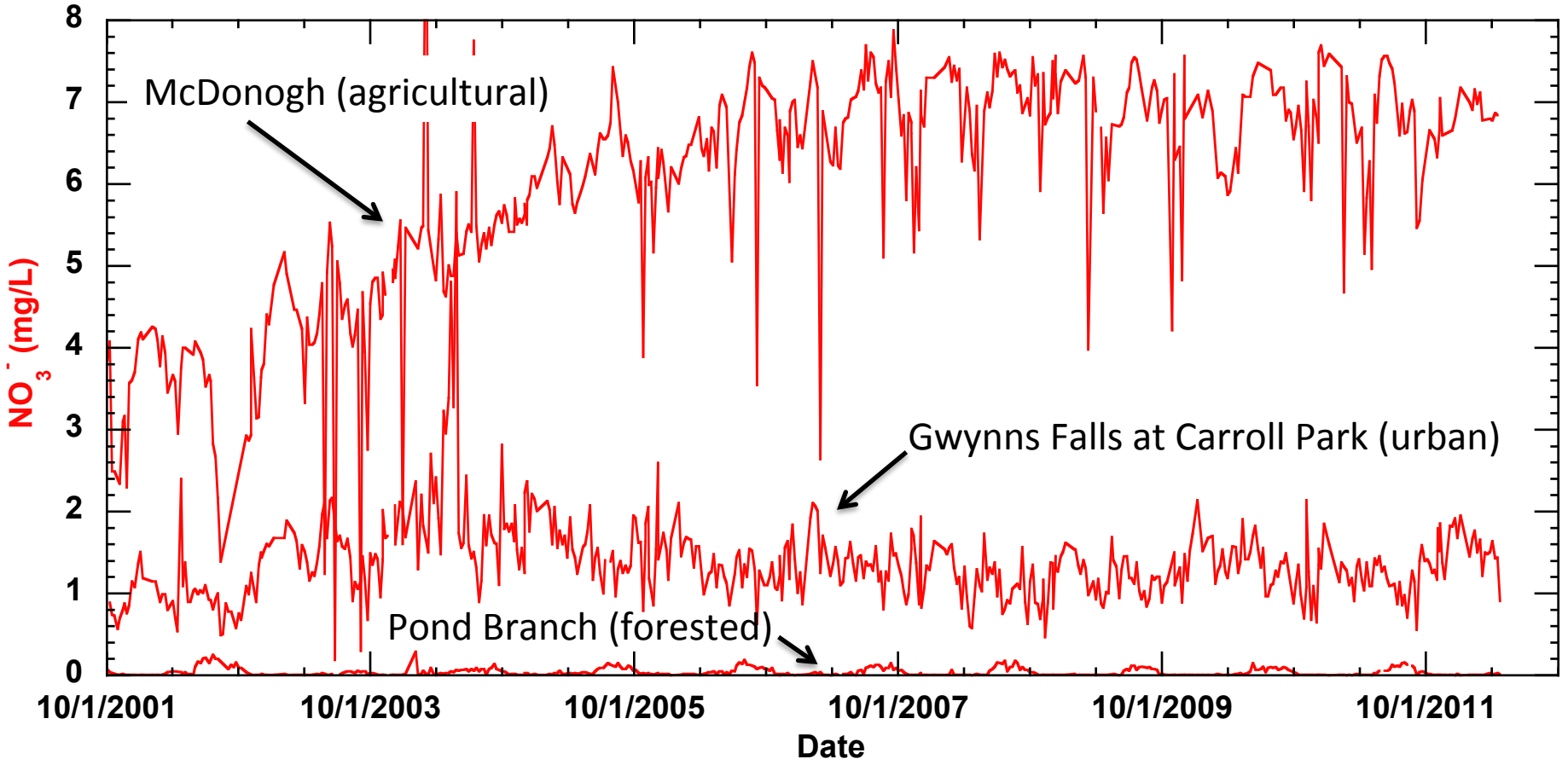
Gwynns Falls Watershed



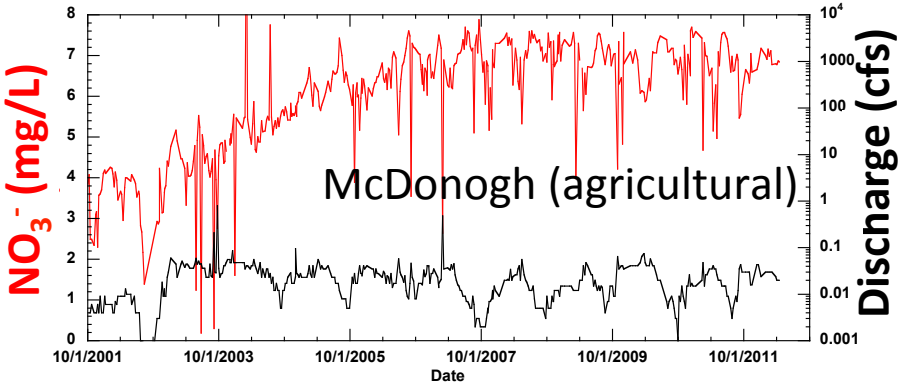
Watershed	Area (km^2)	Percent Imperv-ious
Pond Branch (forest)	0.4	0
Baisman Run (forest/ exurban)	3.8	5
Glyndon	0.7	21.1
Delight	10.6	18.6
Villa Nova	84.5	21.1
Carroll Park	171	30.3
Dead Run (urban)	14.1	45
McDonogh (agriculture)	0.06	0

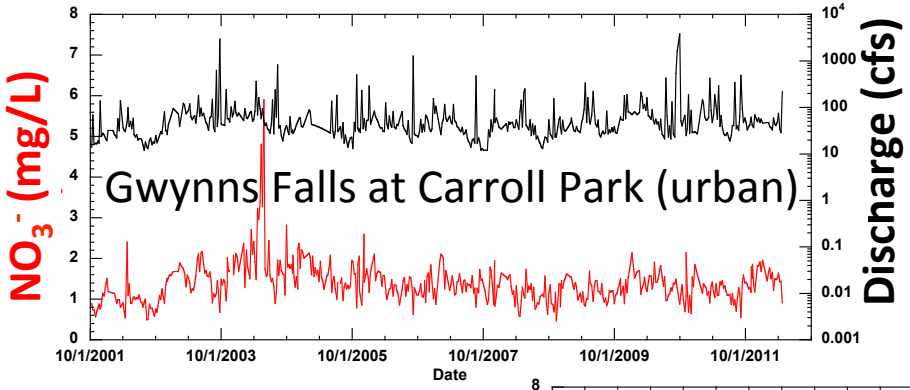
Data available for download from beslter.org

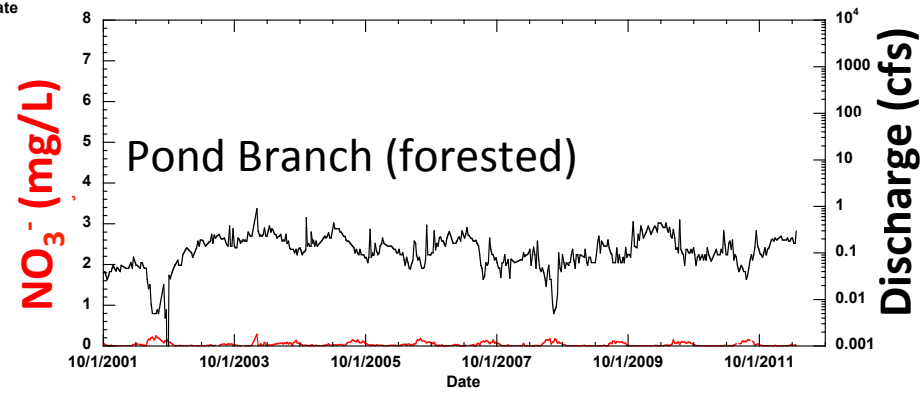
BES weekly data – example nitrate concentration time series



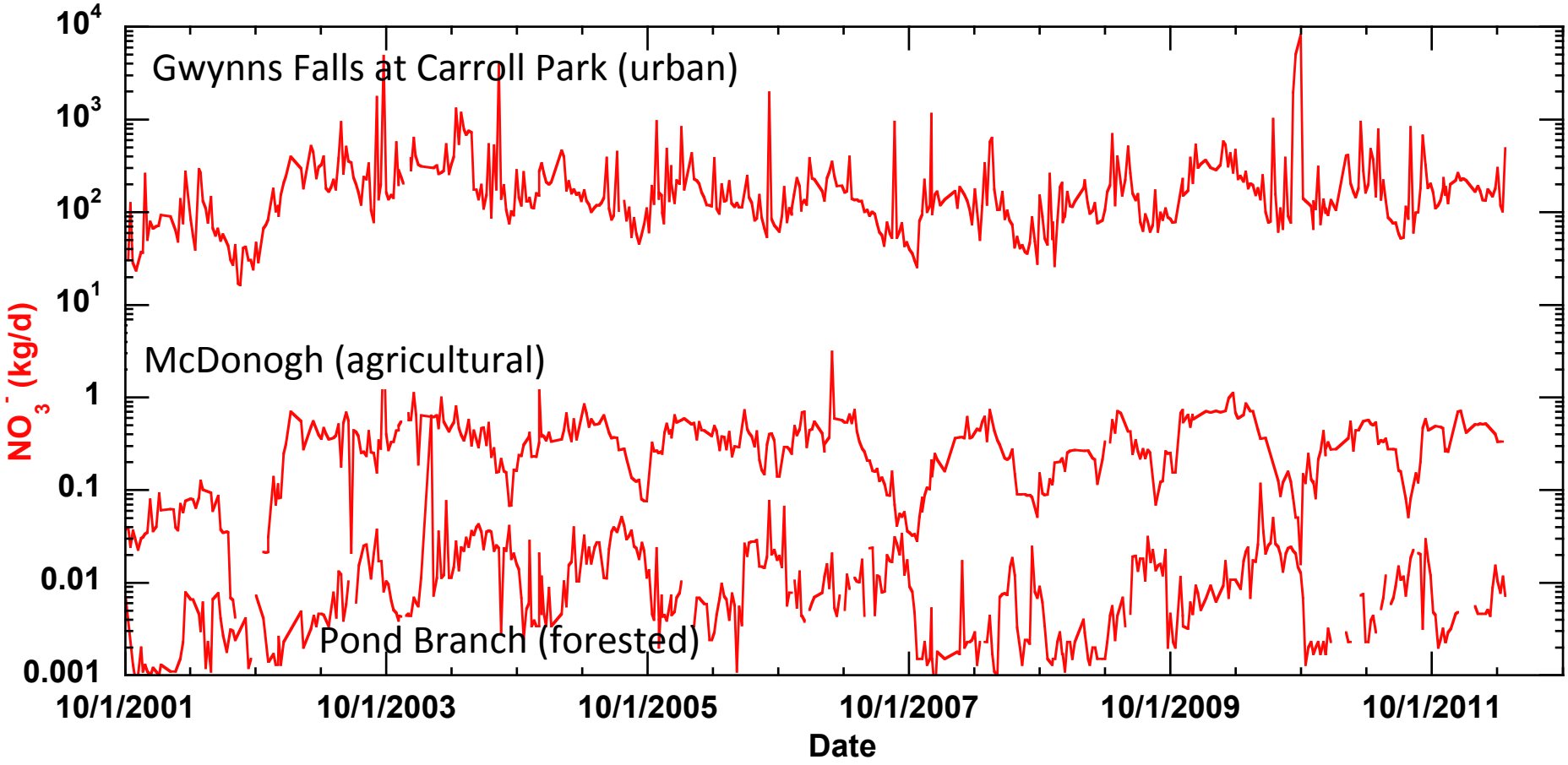
BES weekly data – nitrate + discharge time series



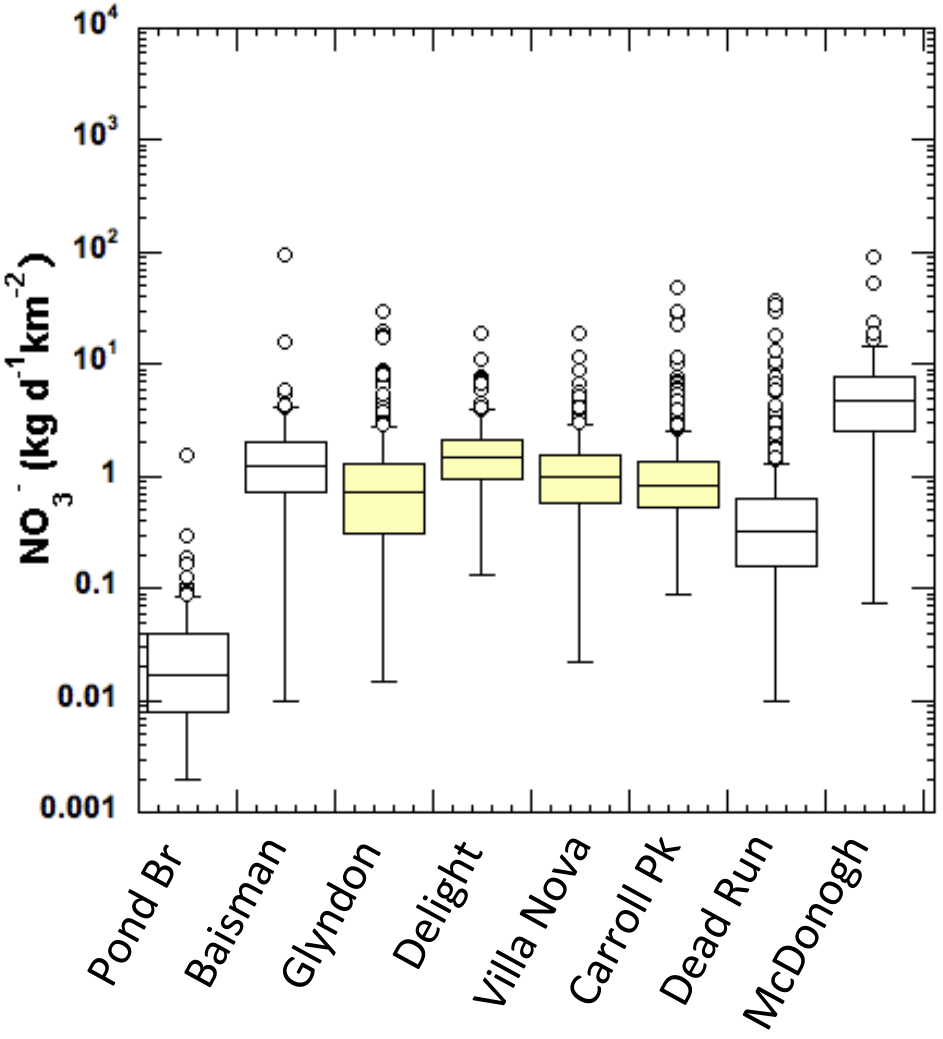




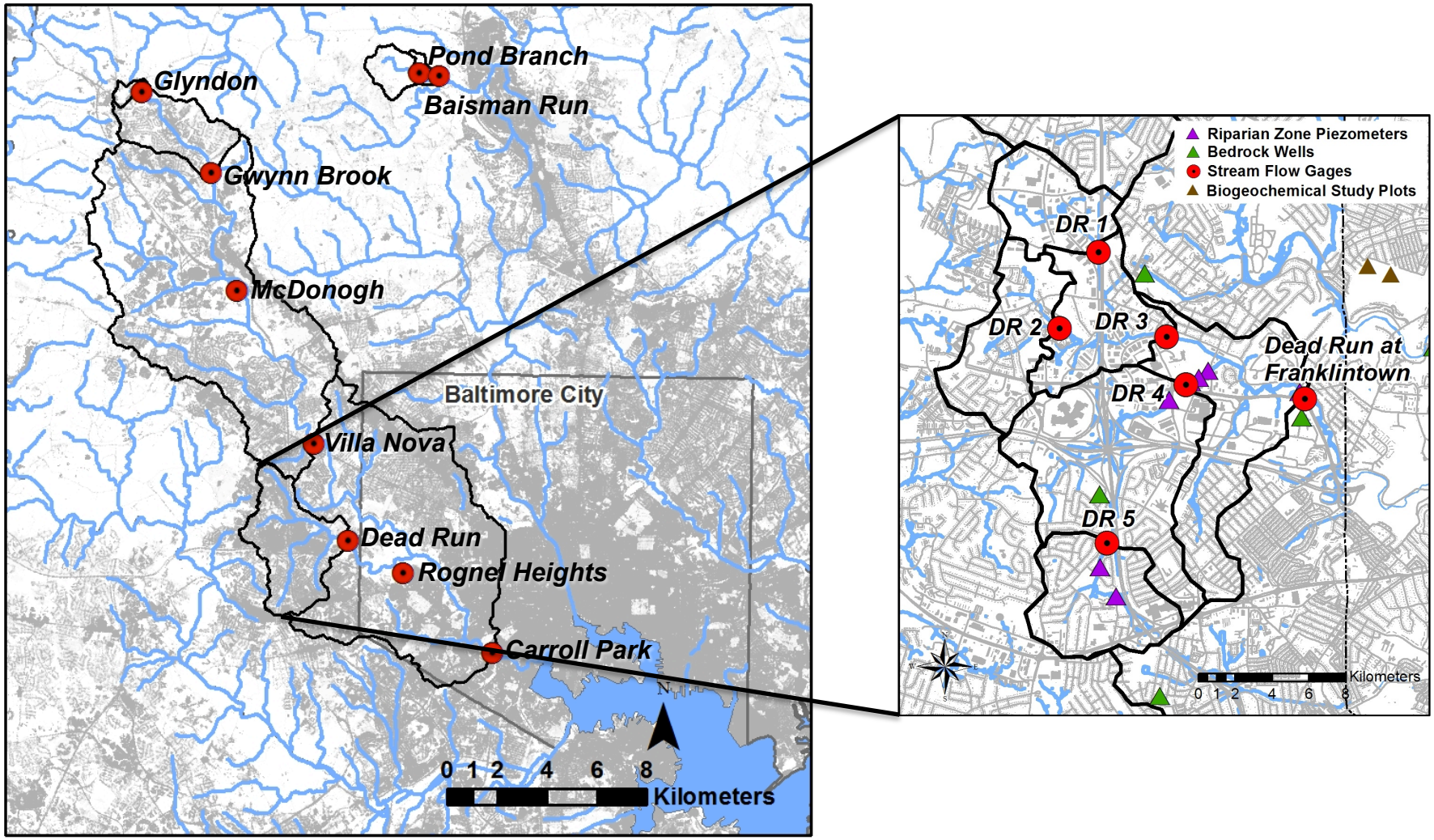
BES weekly data – nitrate daily loads



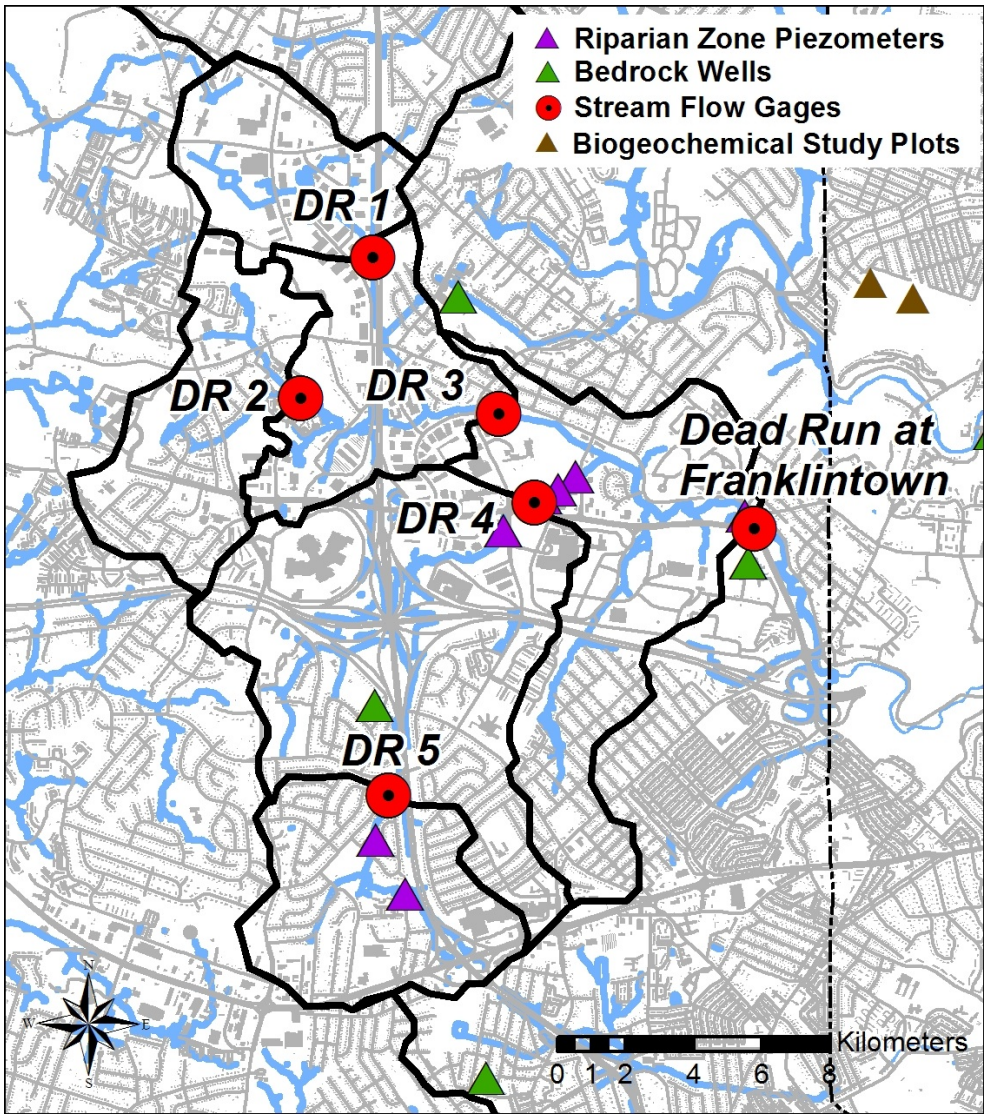
BES weekly data – nitrate yields



Dead Run Watershed



Dead Run Watershed



14.1 sq km

45% impervious cover

6 USGS stream gages

Nested watershed design

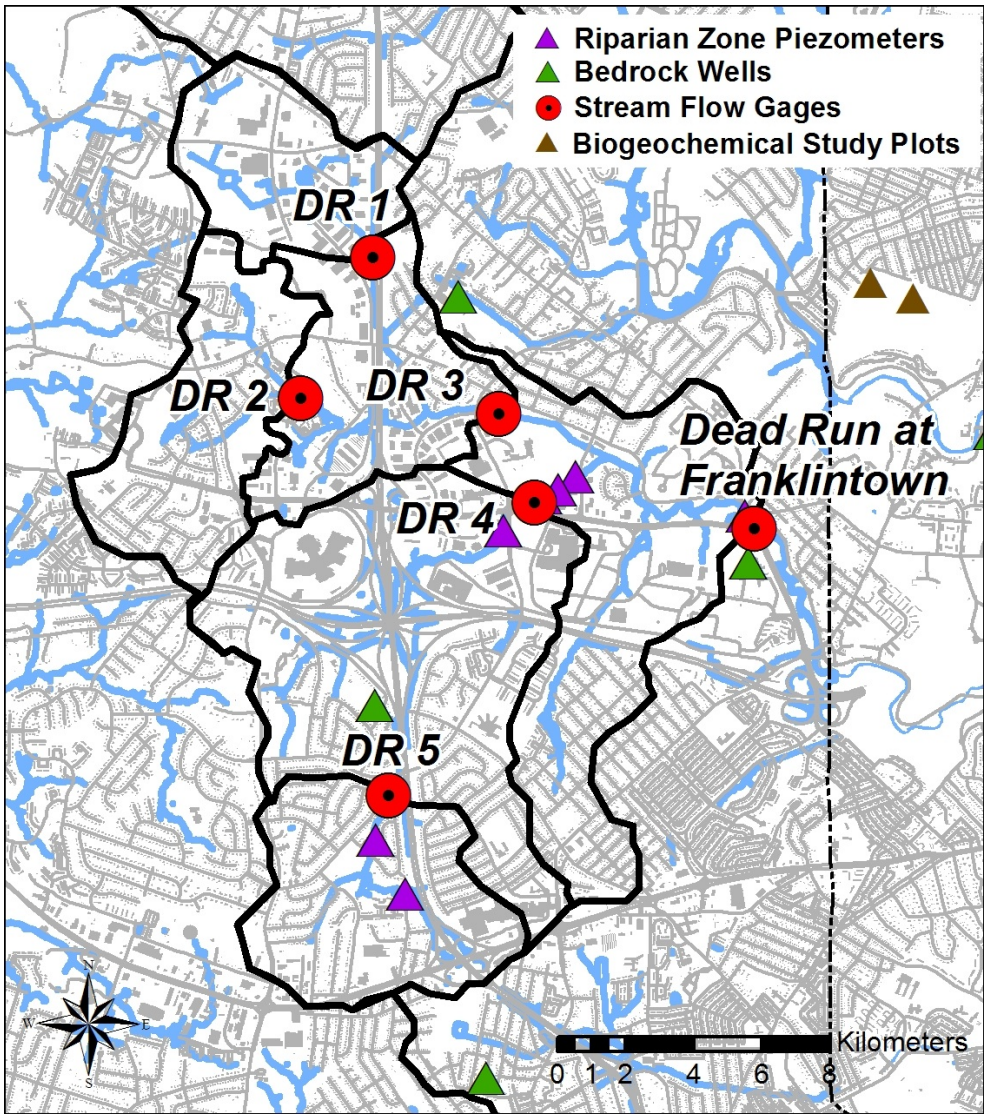
High-frequency sensors deployed since 2010

30-minute sampling

NO_3^- (Satlantic SUNA)

SC, temperature, DO, turbidity (YSI EXO2)

Dead Run Watershed



Watershed	Area (km^2)	Percent Imperv-ious
DR1	1.3	51
DR2	1.9	45
DR5	1.5	45
DR3	5.0	48
DR4	6.2	50
DR Franklintown	14.1	45

Satlantic SUNA

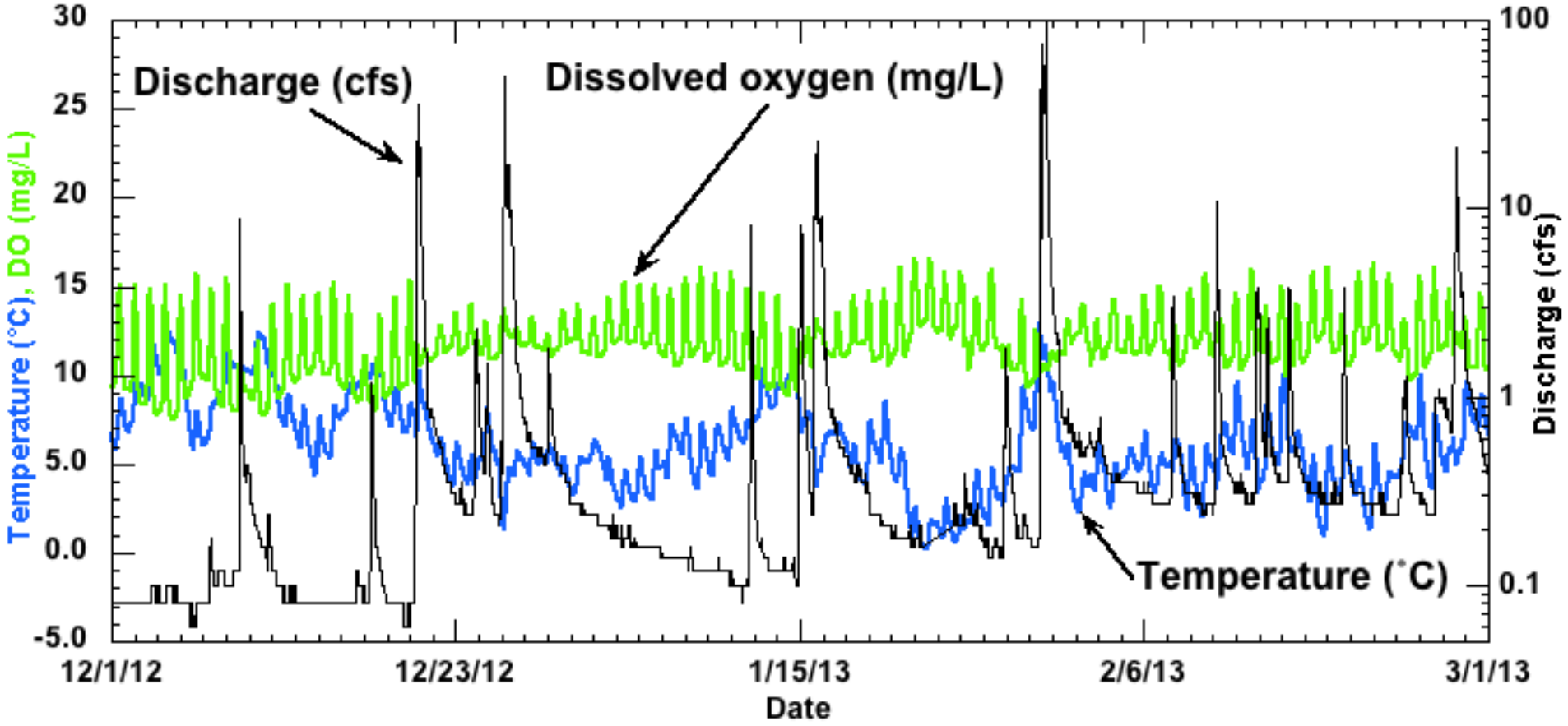
- Submersible Ultraviolet Nitrate Analyzer
- Ultraviolet absorption spectroscopy
- In-situ measurement of nitrate N
- Detection range: 0.007 to 28 mg/L as N
- Precision: 0.028 mg/L as N
- Accuracy: ~ +/- 10% of reading
- Cost per unit: ~$22K (without peripherals)

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 ±2% of reading
- Cost per unit: ~ $10K (without peripherals)

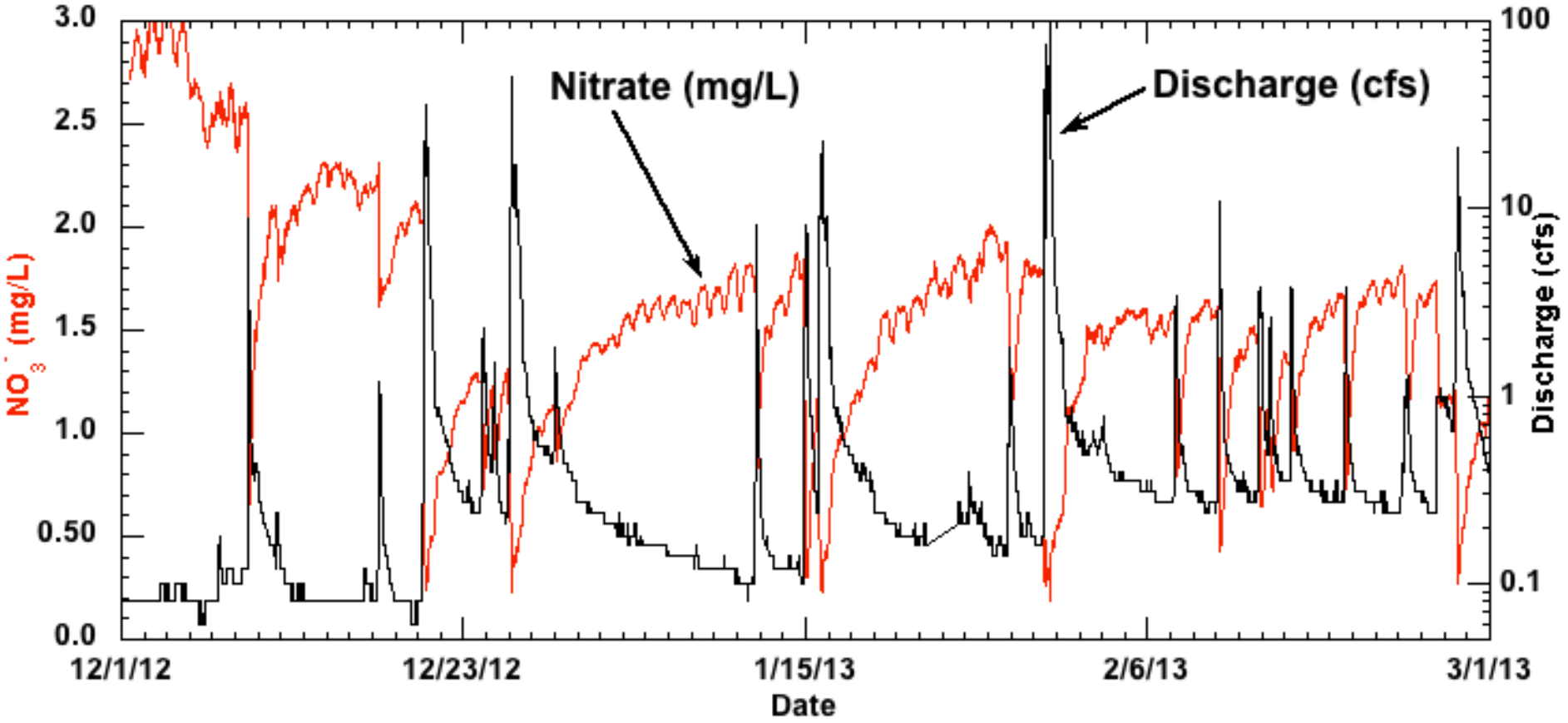
Example data from one site (DR1)

Discharge, DO, and temperature



C. Welty, unpublished data

Nitrate and discharge



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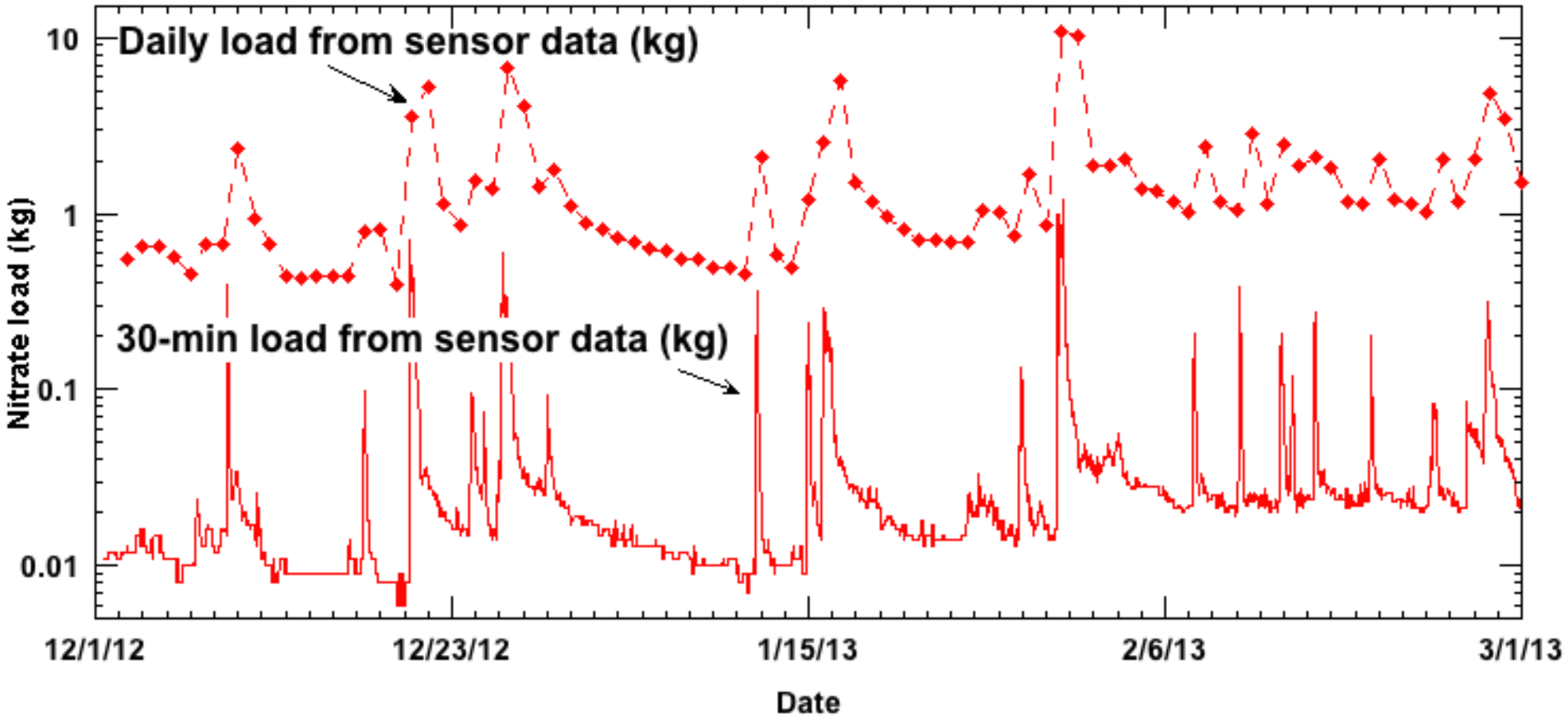
Nitrate load calculations



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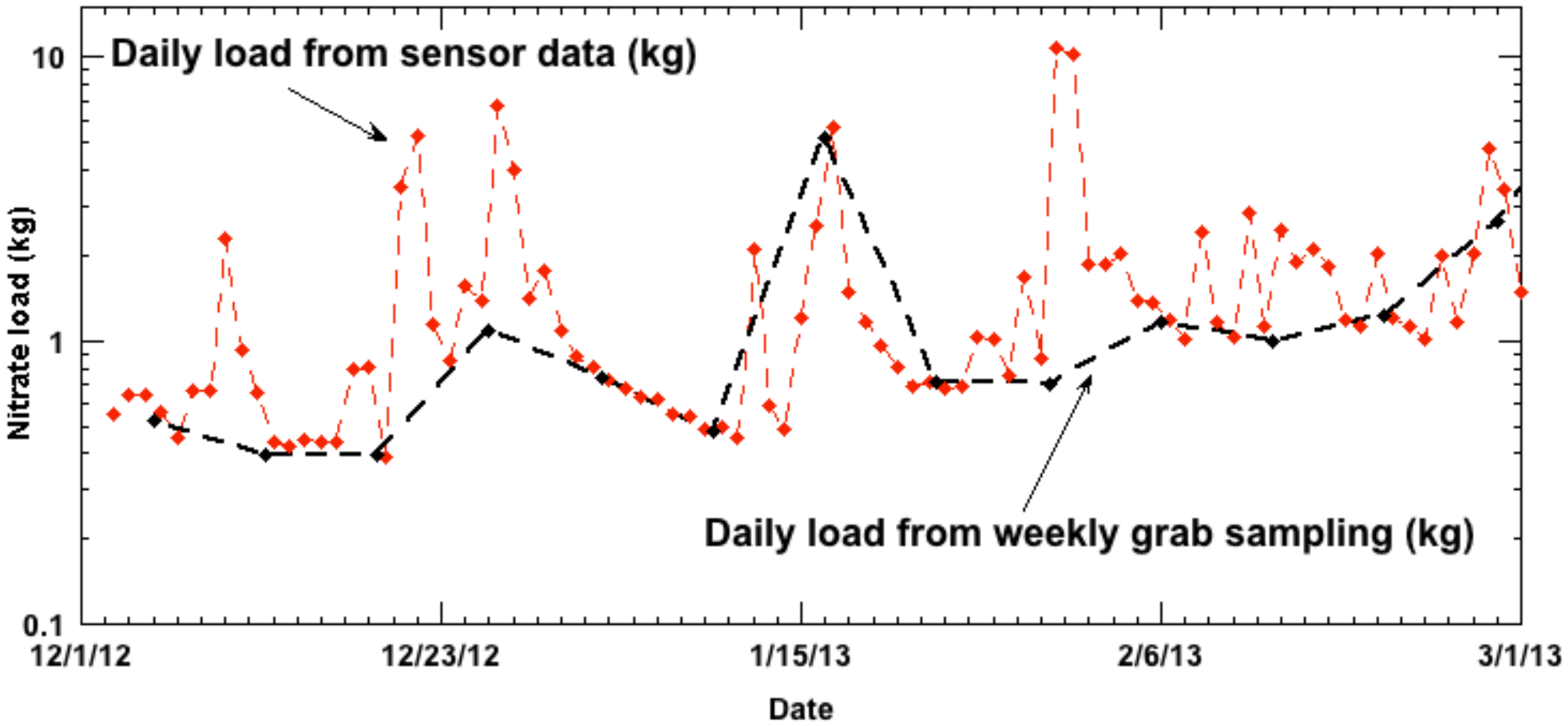
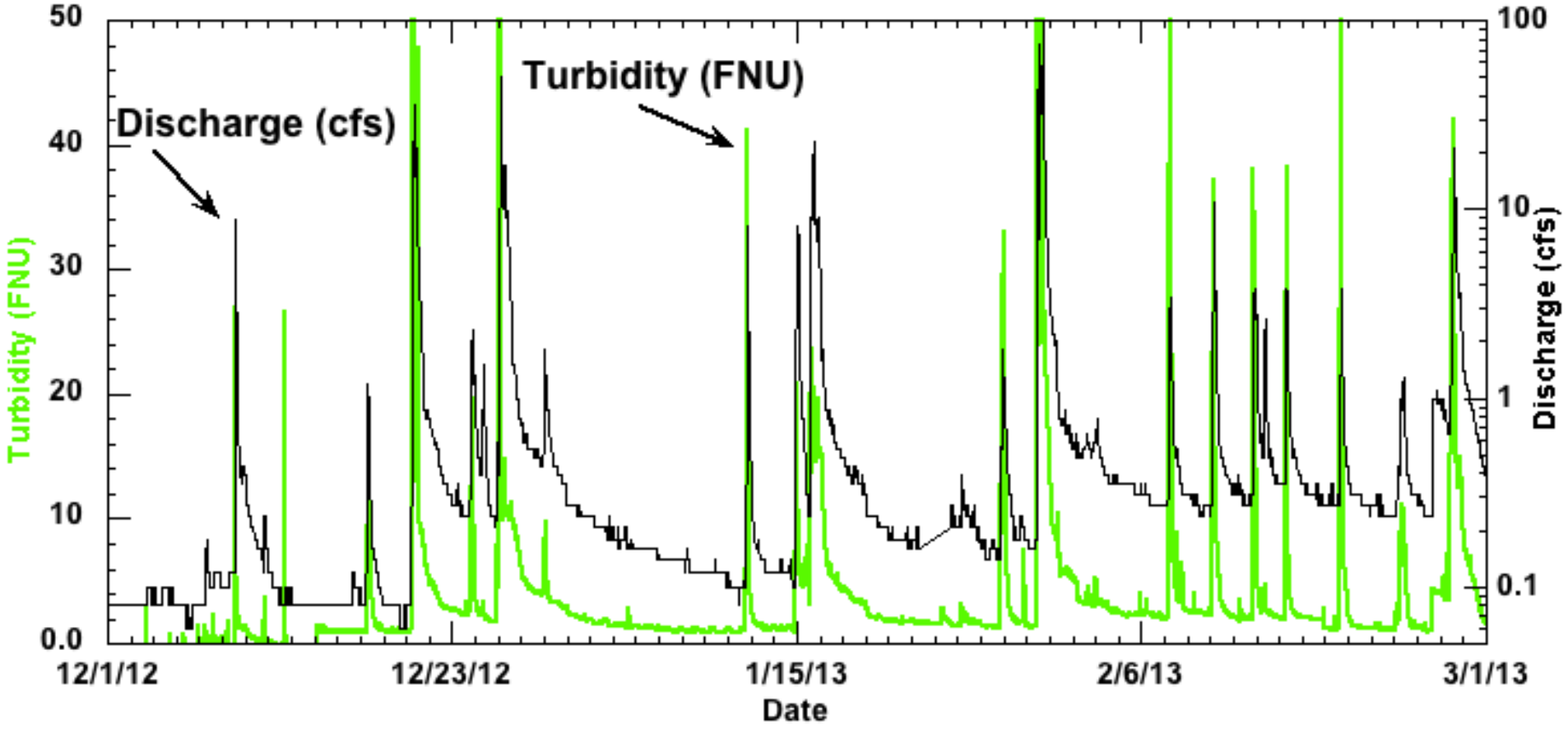


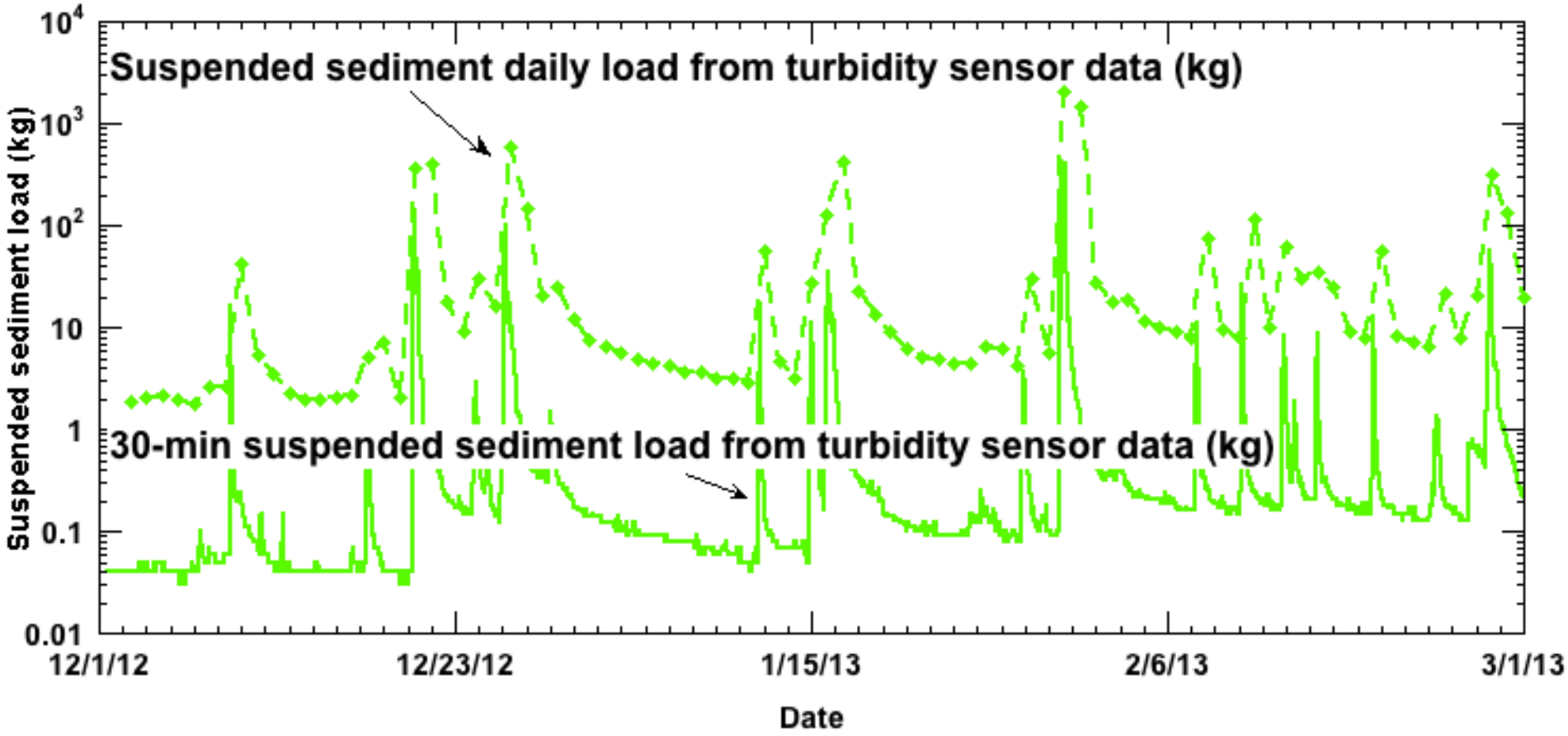
C. Welty, unpublished data

Turbidity and discharge



C. Welty, unpublished data

Suspended sediment load calculations



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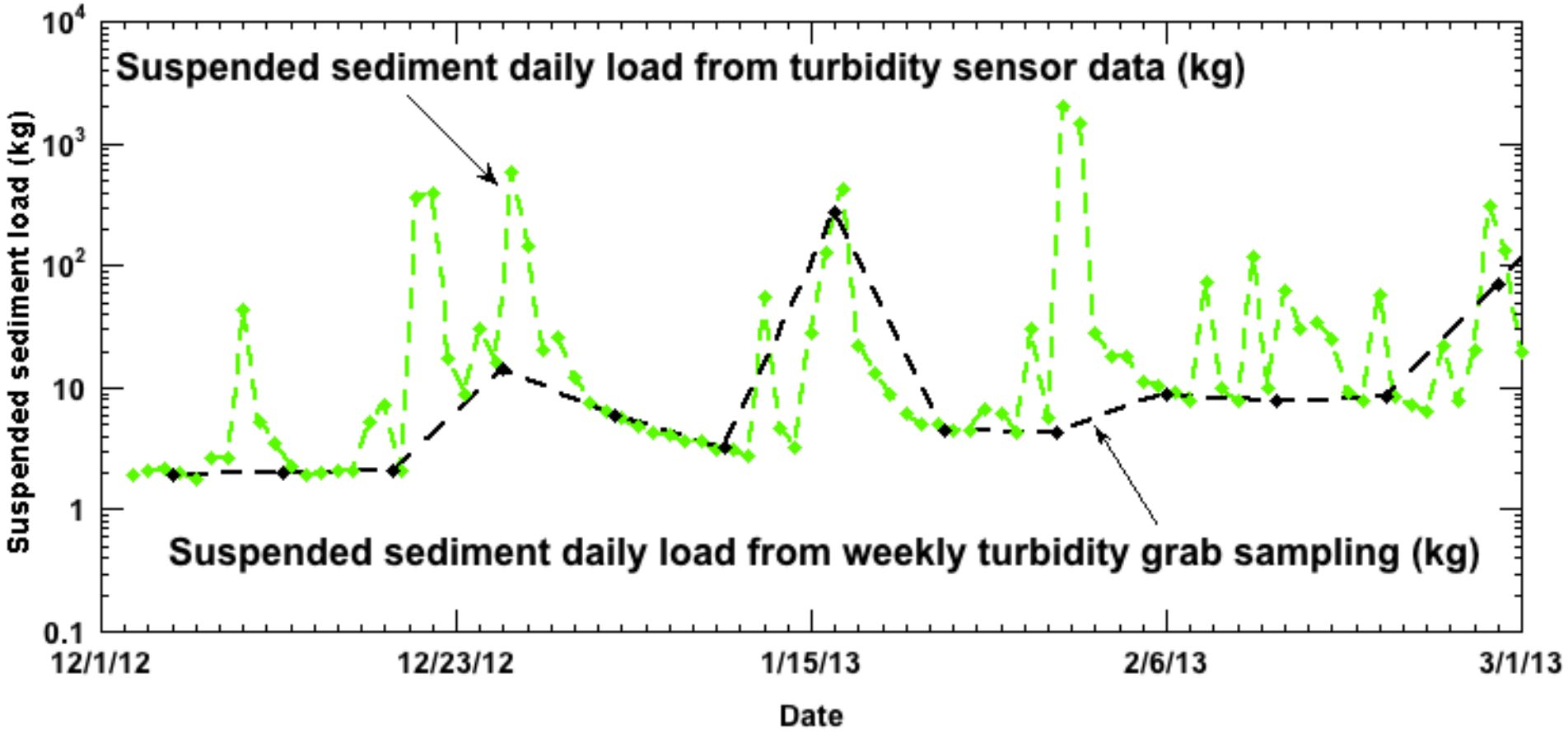
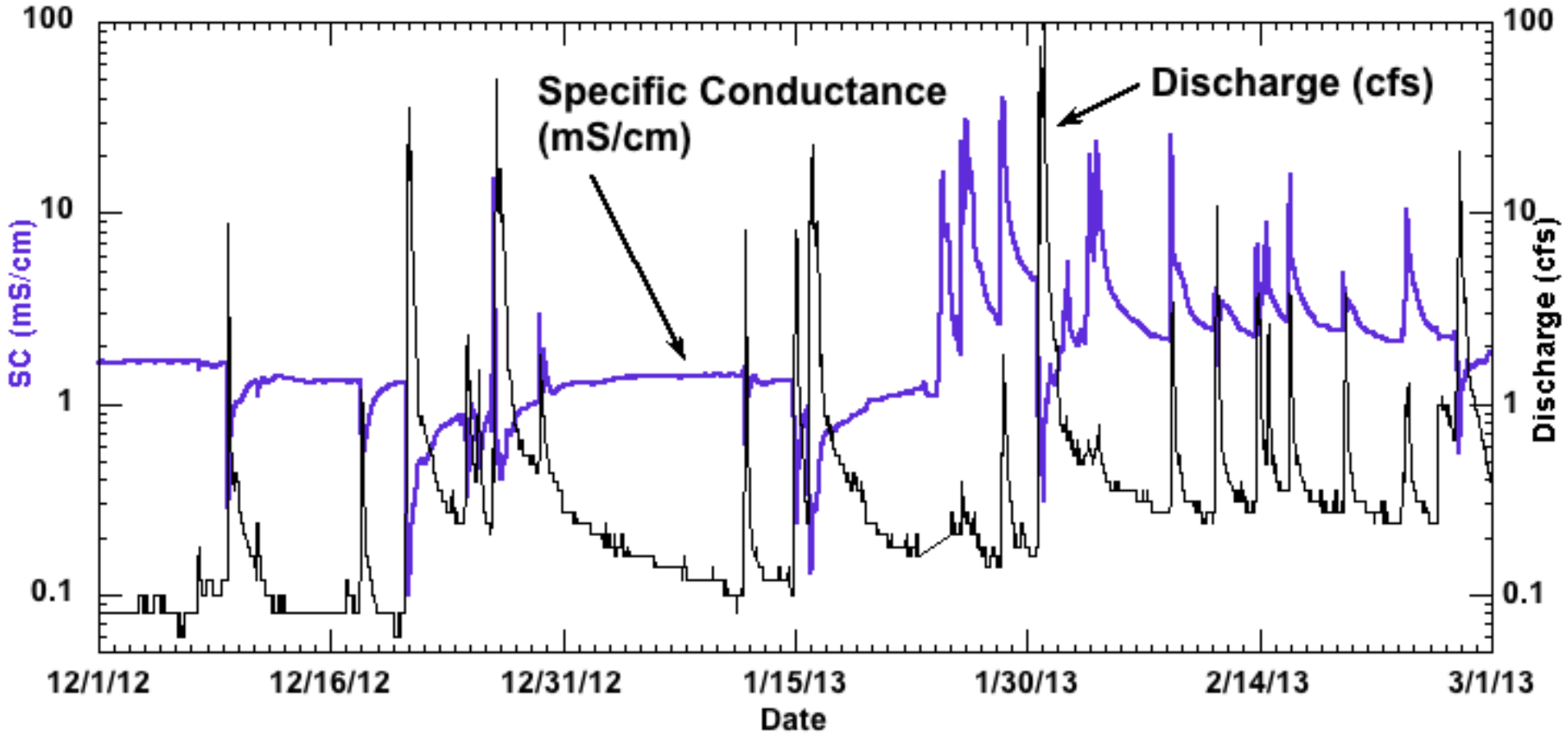


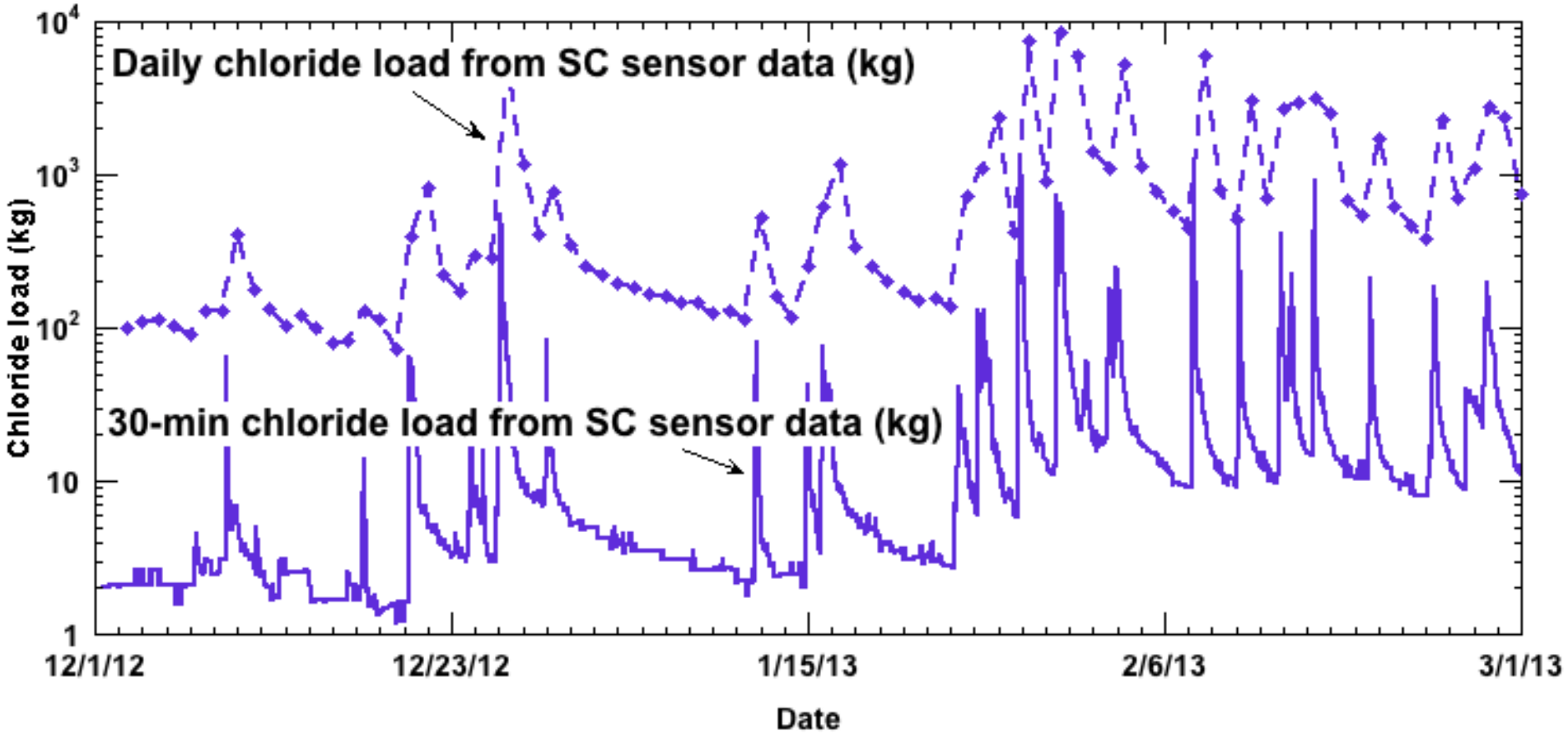
C. Welty, unpublished data

Specific conductance and discharge



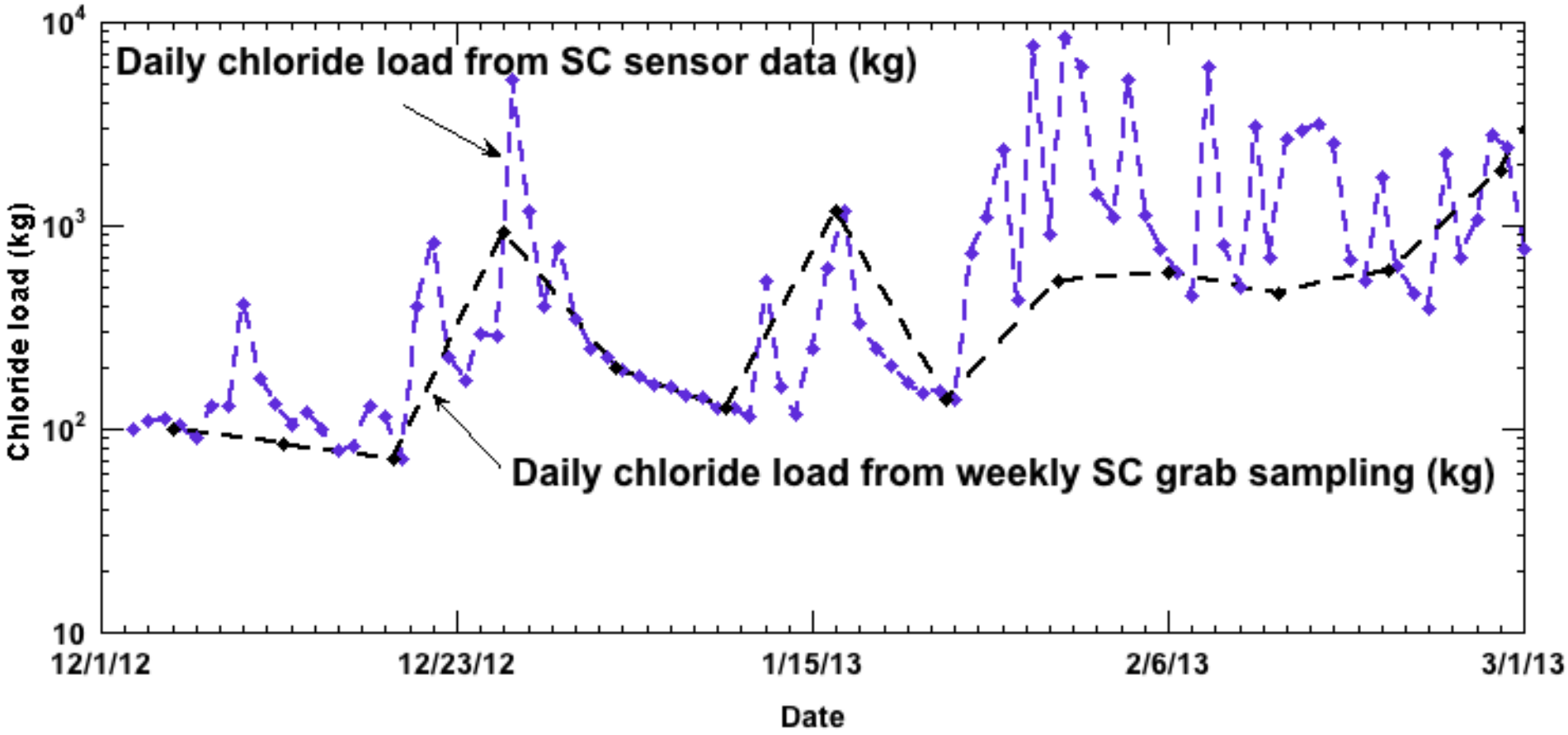
C. Welty, unpublished data

Chloride load calculations



C. Welty, unpublished data

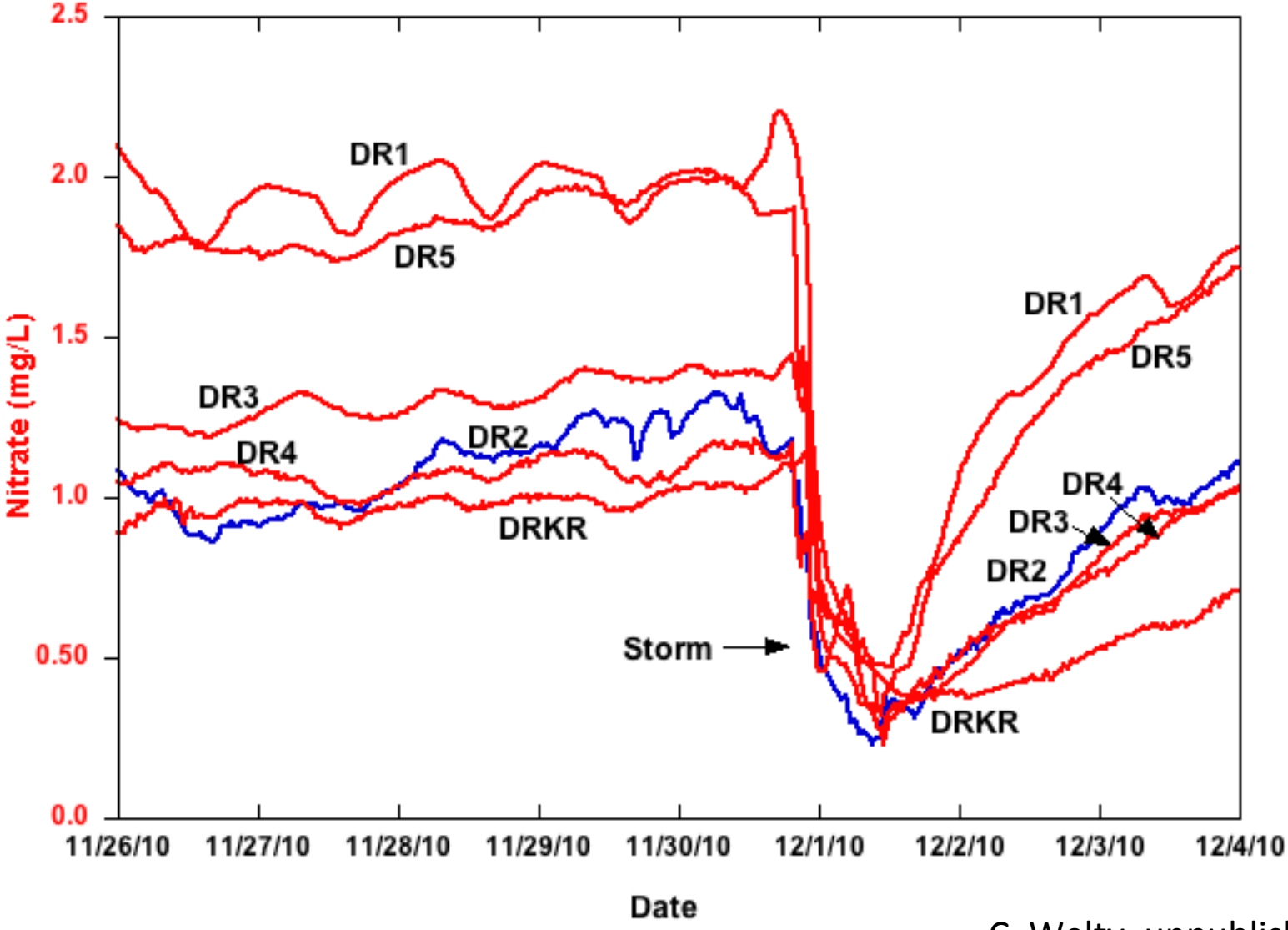
Chloride load calculations



C. Welty, unpublished data

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 – pharmaceuticals, toxics
- Integration of modeling and observations at fine grid scales

Acknowledgements

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