Research Overview

National Water Quality Laboratory

USGS

Lakewood, CO

NRP/LEAG Meeting

April 22, 2009

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Agenda

- Quick overview of the NWQL
- Ongoing research at the NWQL
- Snapshots of a few current projects
- Future directions…

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The NWQL: What we do…

- Develop modern methods for environmental analysis
- Analyze water, wastewater, soil and tissue in support of international, national and state programs
- Collaborative research with other government agencies

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NWQL Areas of Expertise

- Methods Research and Development
- Inorganic, Organic and Radiochemistry
- ID & Quantitation of Benthic Invertibrates
- Varied Matrices:
  Water, Wastewater, Sediment, Tissue
- Admin, Support Services, QAS, IT, BDT

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Key Inorganic Chemistry Capabilities

- **Nutrients: Ortho-P, ammonia, nitrate, nitrite**
- **Metals: whole & filtered water: ICP & ICP/MS**

- **Bromide: filtered by IC**
- **Iodide, silica: filtered by colorimetric flow**
- **Fluoride: filtered by ISE**
- **Major anions: filtered by IC**
- **Radchem, Hg, As speciation**
- **Etc., etc. – see online catalog at nwql.usgs.gov**

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Key Organic Chemistry Capabilities

- Pesticides
- Volatiles
- Emerging Contaminants
  - Wastewater Indicators
  - Pharmaceuticals
  - Hormones
  - Endocrine Disruptors
- High Production Volume chemicals

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Biological Services

- Macroinvertebrate Sample Production
  - Subsampling & Sorting
  - Taxonomic Identification
  - ~ 800 samples/yr.
  - Key to USGS ecosystems focus

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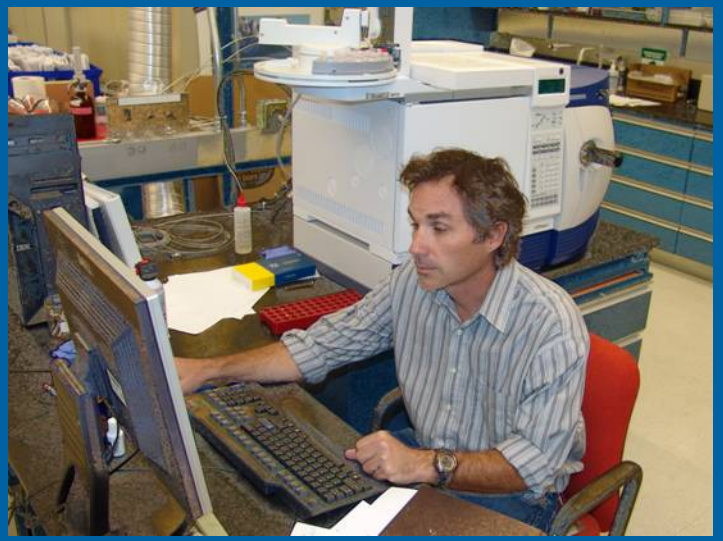
Method Development at the NWQL



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Methods Research at the NWQL: Analytical Focus

- Improved integrative sampling technology
  - Suspended Sediment Integrative Samplers
  - Polar Organic Chemical Integrative Sampling (POCIS)
- Improved Sensitivity and Selectivity:
  - Direct Aqueous Injection LC/MS/MS
  - High mass resolution TOF/MS
  - Isotope dilution MS/MS
- Green Chemistry, Automation & Efficiency:
  - ASE Sediment/Tissue Prep Methods
  - Replacement of Cadmium w/ nitrate reductase
  - Kone Discrete analyzer

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Ongoing Research Projects (incomplete list)

- **Integrated suspended sediment samplers**
- **Pharmaceuticals in water, tissue and sediment**
- **Wastewater indicators from biosolids**
- **Persistence of emerging contaminants through the waste treatment processes**
- **Hormones in water, sediment and tissue**
- **High Production Volume chemicals in water**
- **Elimination of Cadmium with $NO3^-$ Reductase**
- **Silica: move from SFF to Discrete method**

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science for a changing world

Glyphosate in suspended sediment in streams from two agricultural areas of the United States

Mark Sandstrom, Max Stroppel, **Michael Meyer**,
Claire Rose, Richard Coupe, and Steven Kalkhoff

U.S. Geological Survey

(SETAC, 2008)

U.S. Department of the Interior
U.S. Geological Survey

Introduction

- **Glyphosate-based herbicides are used for control of weeds on corn, soybeans, and cotton.** **(High volume, broad geographical usage)**
- **Glyphosate is strongly adsorbed by soils and stream sediment.**
- **Dissolved glyphosate has been found frequently in tile drains and streams in agricultural areas (Battaglin and others, 2005).**

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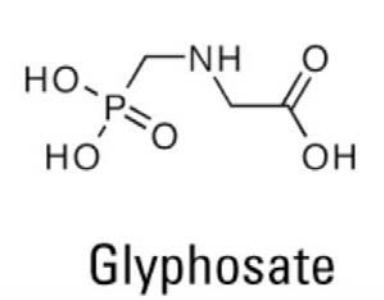
Battaglin, W.A., Kolpin, D.W., Scribner, E.A., Kuivila, K.M., and Sandstrom, M.W., 2005, Glyphosate, other herbicides, and transformation products in mid-western streams, 2002: Journal of the American Water Resources Association (JAWRA), v. 41, no. 2, p. 323-332.

Study Objectives



- Evaluate importance of suspended sediment in transport and fate of glyphosate from agricultural fields into streams

- Evaluate time-integrating sediment samplers ability to collect fine-grained suspended sediment

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Time-integrated suspended sediment sampler for small watersheds

- Simple design based on sedimentation of particles (Phillips, et al, 2000)
- Operates unattended, no power requirements
- Composite sample collected continuously over period of days to weeks
  - Samples entire storm runoff event
- Collects sufficient mass for variety of geochemical analyses

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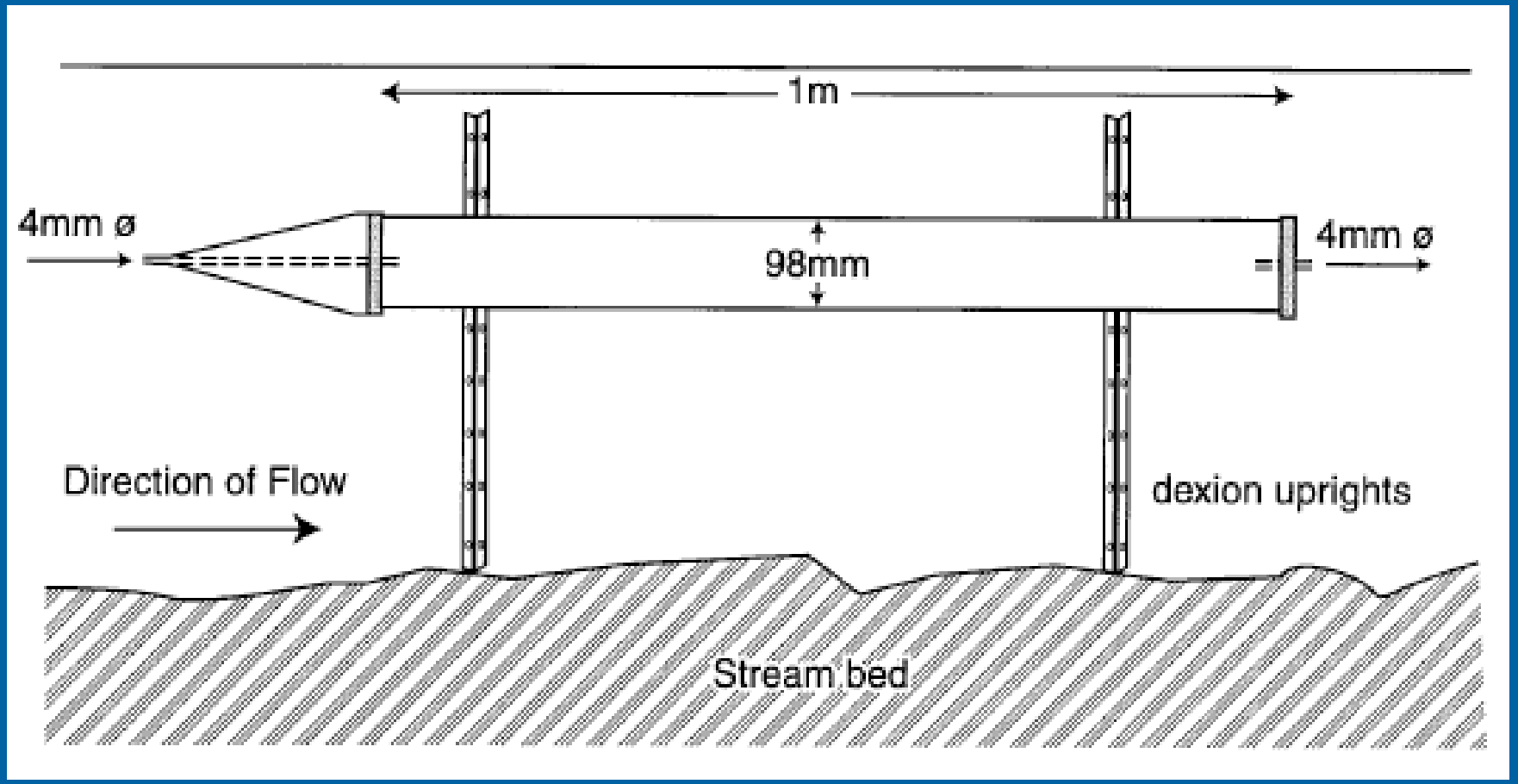
Phillips, J.M., Russell, M.A., and Walling, D.E., 2000, Time-integrated sampling of fluvial suspended sediment: a simple methodology for small catchments: Hydrological Processes, v. 14, no. 14, p. 2589-2602.

Time-integrated suspended sediment sampler for small watersheds



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Suspended sediment sampler operation

- Sampler submerged in stream with inlet orientated directly into the flow
- Within main cylinder flow velocity is reduced by ~600 times ambient flow
- Reduction in flow velocity induces sedimentation

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Fraction of total glyphosate in suspended sediment

Stream Site	Sample Event	Glyphosate in sediment samplers, in ng/g	Median concentration of suspended sediment in mg/L	Calculated glyphosate in suspended sediment in ng/L	Median concentration of glyphosate in filtered stream samples, in ng/L	Glyphosate in suspended sediment, in percent of total glyphosate in water
Blairsburg, IA	**1**	**111**	**44**	**4.9**	**80**	**6.1**
	2	**172**	**34**	**5.8**	**675**	**0.9**
New Providence, IA	**1**	**37**	**19.5**	**0.7**	**60**	**1.2**
	2	**79**	**204**	**16.1**	**320**	**5.0**
Tommie Bayou, MS	**1**	**1043**	**110**	**114.7**	**890**	**12.9**
	2	**437**	**-**	**-**	**-**	
Bogie Phalia, MS	**1**	**1755**	**86**	**150.9**	**1,690**	**8.9**
	2	**1528**	**81**	**123.8**	**1,015**	**12.2**

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Conclusions

- Time-integrating sediment samplers samplers were effective in the collection of suspended sediment during major storm-runoff at each location.
- Glyphosate in suspended sediment represented a small fraction (1 - 12 percent) of the total glyphosate concentration in the stream.

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Fate of Antidepressants Downstream of the Boulder Creek, CO Wastewater Treatment Facility

- Ed Furlong, Melissa Schultz - NWQL
- Note: data is preliminary, research ongoing
- Matrices: water, fish brain, sediment
- Bottom line: Are differences seen due to metabolism in fish? Due to chemical property differences in water vs. sediment?

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Boulder Creek Antidepressants: Comparison Between Media Downstream of WW Outfall

	Water (ng/L)	Brain (ng/g)	Sediment (ng/g)*
Fluoxetine	9	0.6	12
Norfluoxetine	4	0.9	2.3
Sertraline	3	1.5	11
Norsertraline	4	2.5	8.7
Paroxetine	4	ND	2.4
Citalopram	60	0.07	10
Bupropion	50	0.05	1.7
Venlafaxine	220	ND	21
*Provisional Results			

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Land Application of Biosolids - II

Mobilization of Microconsituents from Land-Applied Biosolids via Simulated Rainfall

- Ed Furlong, (NWQL), Thomas Borch, Jessica Davis (CSU), Tracy Yager (USGS Colorado WSC)
- Coordinated with Metro Wastewater Reclamation District
- First-time application of biosolids (Roggen,CO)
- Artificial rainfall applied; runoff collected..
- Samples analyzed for:
  - Wastewater indicators
  - Pharmaceuticals, hormones
  - Nutrients, Organic carbon

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Mobilization of Wastewater-Indicator Compounds From Biosolids Treated Sites - Simulated Rainfall

Elapsed time following application	1 day	8 days	35 days
	Average Triclosan Concentration ug/l		
Rainfall Simulaiton - Beginning	0.25	0.20	0.38
Rainfal Simulation - Middle	0.33	0.34	0.39
Rainfal Simulation - End	0.31	0.32	0.50

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(preliminary results)

Mobilization of Wastewater-Indicator Compounds From Biosolids Treated Sites - Simulated Rainfall

Elapsed time following application	1 day	8 days	35 days
	Average DEET Concentration ug/l		
Rainfall Simulaiton - Beginning	0.14	0.48	ND
Rainfal Simulation - Middle	0.10	0.59	ND
Rainfal Simulation - End	0.09	0.33	ND

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(preliminary results)

Future Directions in Method Development

- **Collaborate with ecosystem-focused studies**
- **Ecological biomagnification / metabolism studies**

- **Data Mining / Automation**
- **Direct Aqueous Injection**

  LC/MS/MS
  - Pharmaceuticals
  - HPV Compounds
  - Pesticides
  - Polar Indicators
- **LC/ToF MS for TICs**

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