Effects of Land Use on Stable Carbon Isotopic Composition and Concentration of DOC and DIC in Southeastern US Piedmont Headwater Streams

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Objective

- Evaluate, and develop simple models to describe, the impact of land use on the concentrations and $\delta^{13}C$ of dissolved organic carbon (DOC) and dissolved inorganic carbon (DIC) in headwater streams

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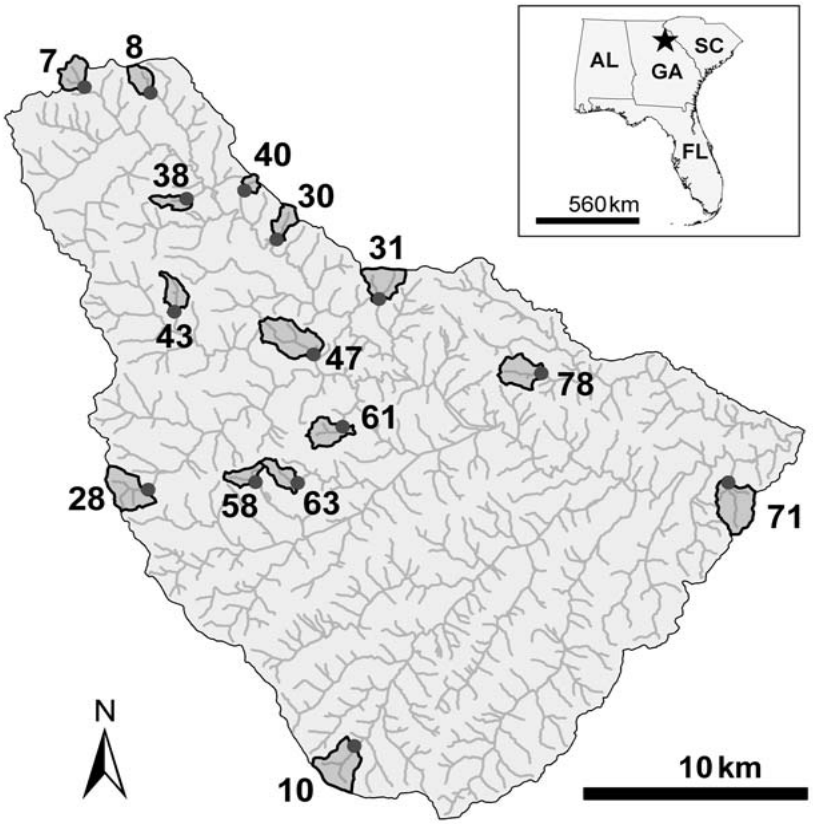
South Fork Broad River Watershed



Major Stressors in South Fork Broad River (SFBR), GA Watershed

- Rapidly growing human population with ~ 90% of homes on septic tanks
- Intensive poultry production – resulting poultry litter added to mixed bermuda (C_4 grass, $\delta^{13}C$ ~ -12 ‰) / fescue (C_3 grass, $\delta^{13}C$ ~ - 27 ‰) pastures
- Associated cattle production also responsible for organic waste inputs

Approach

- Monthly monitoring in 15 SFBR headwater streams in 2008 – 2009.
- Watersheds exhibit a wide range of land use and fall along a gradient of organic waste inputs – carbon subsidies range from 2 to 28 %
- In previous study used landscape indicators to describe dissolved organic matter concentrations in these same streams

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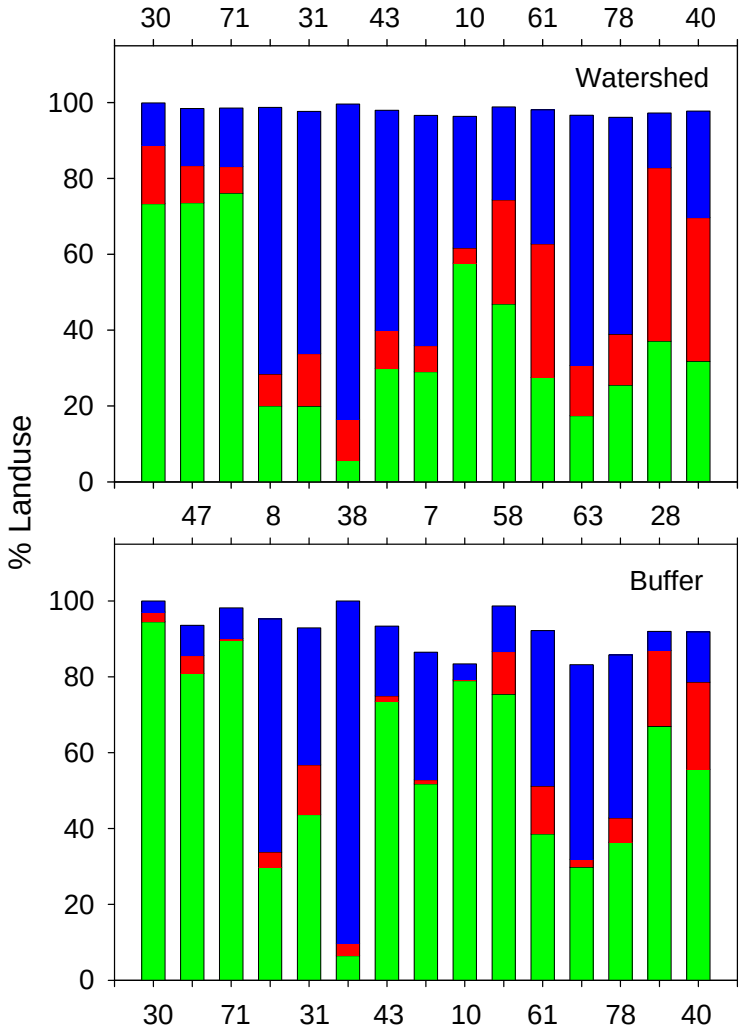
2001 National Land Cover Data



Green – forest

Blue – pasture

Red – developed

Analysis techniques

- Water samples field-filtered (GF/F) into VOA vials with either teflon (DOC) or butyl (DIC) septa
- Analyses with persulfate-based total carbon analyzer coupled to Delta V IRMS
- Discharge (Q) estimated by current meter method

Landscape Analysis Results

- Pasture land cover (Wpas and Bpas) positively correlated with DOC concentration and δ^{13}C-DOC
- Watershed open water (Wwat) positively correlated with DOC and DIC concentrations and negatively correlated with δ^{13}C-DOC
- Watershed developed land cover (Wdev) negatively correlated with δ^{13}C-DIC

Best Robust Linear Regression Models

DV	IVs	adj R^2
DOC (02)*	Bpas (+) Bwet (+)	0.86
DOC (08-09)	Wpas (+) Wwat (+)	0.53
DIC	Wwat (+)	0.36
δ^{13}C-DOC	Wpas (+) Wwat (-)	0.66
δ^{13}C-DIC	Wdev (-)	0.53

* from Molinero & Burke (2009) Hydrobiol. 635: 289 - 308

Stream Monitoring Results

- Discharge pulses generally associated with elevated concentrations of relatively ^{13}C-rich DOC
- DIC – discharge relationship seems more complex; in some cases flow pulses are associated with lower concentrations of relatively ^{13}C-depleted DIC but not in others

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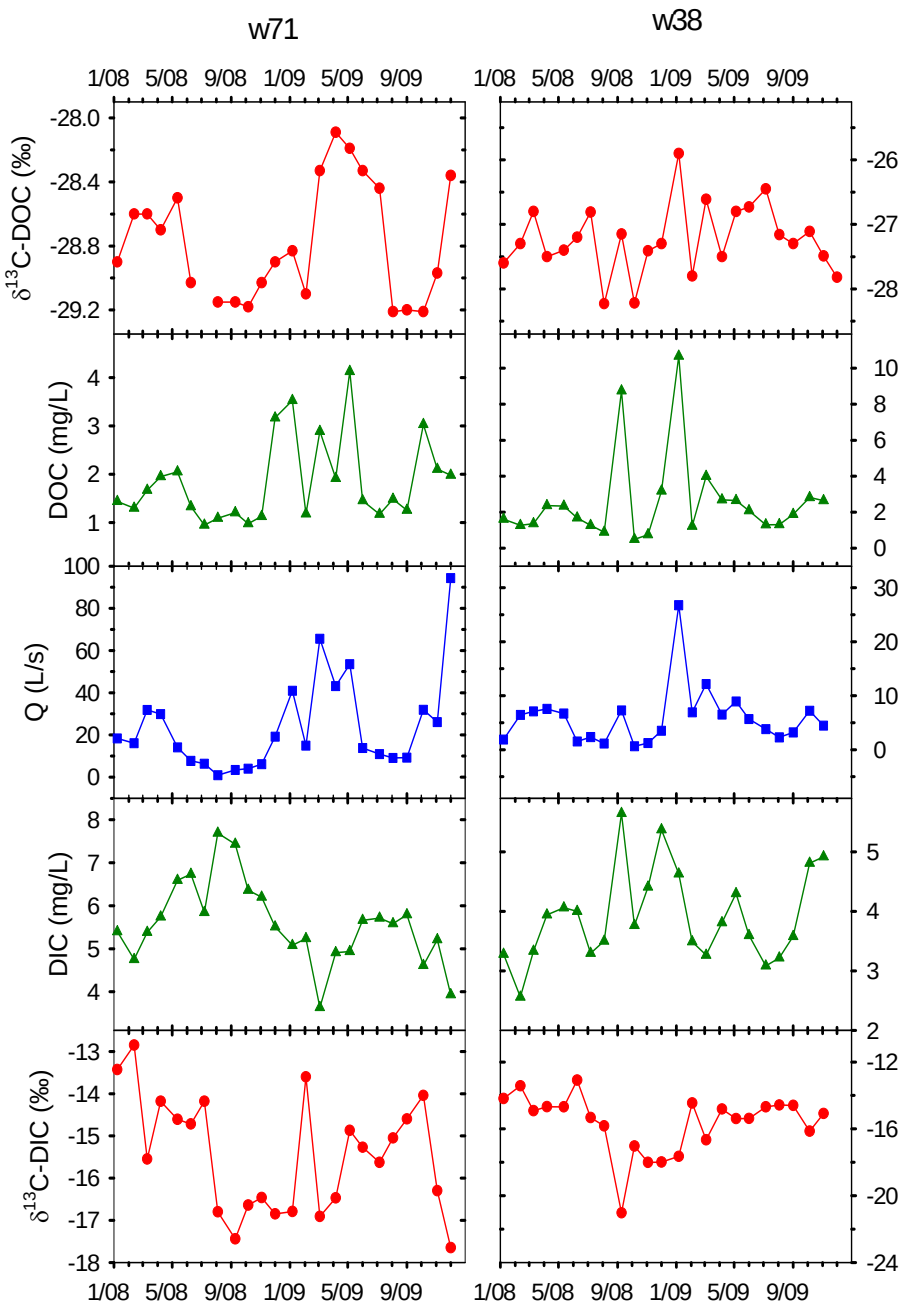

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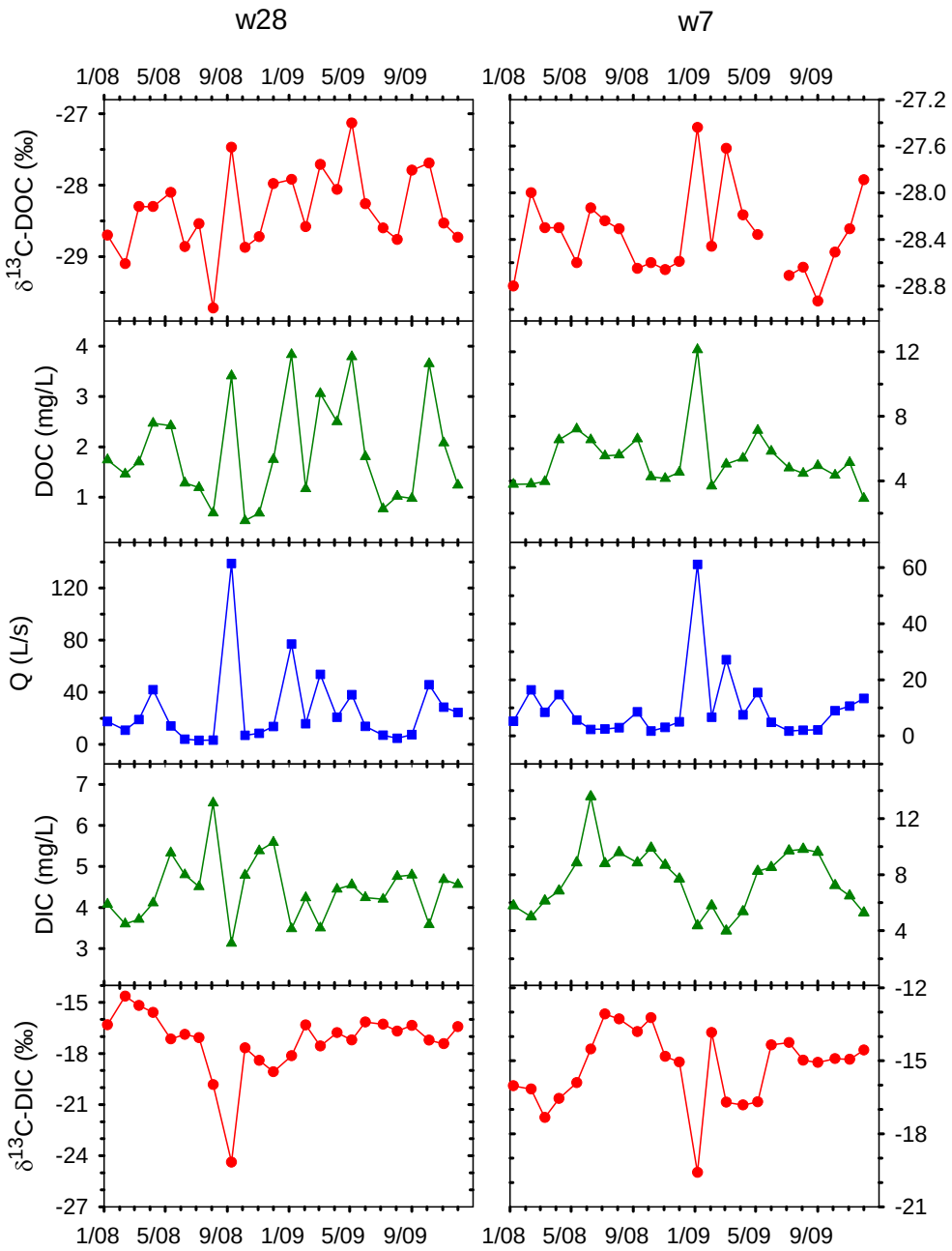

- Potential sources of ^{13}C-enriched DOC

sample	$\delta^{13}C$ (‰)
Water-extracted cattle waste	-22.1 (sd = 2.0)
Rainfall simulator runoff (mixed C_4 and C_3 grasses)*	-25.2 (sd = 1.7)

* No grazing or wastes added for several years prior to runs

Discussion

- Input of ^{13}C-rich organic waste and/or C_4 pasture grass C appears responsible for: **1)** positive correlation of pasture land use with DOC concentration and $\delta^{13}C$; and **2)** increased DOC concentrations and $\delta^{13}C$ associated with discharge pulses
- Increased C cycling in farm ponds most likely responsible for positive correlation of Wwat with DOC and DIC concentrations and inverse correlation with $\delta^{13}C$-DOC

Discussion

- Enhanced weathering rates most likely responsible for inverse correlation between Wdev and δ^{13}C-DIC
- Land use change in intervening six years responsible for changed relationship between DOC concentration and landscape indicators?

Disclaimer

- *Although this work was reviewed by EPA and approved for presentation, it may not necessarily reflect official Agency policy.*