Helping the Upper Oconee River ‘work’ towards nutrient reduction and other ecosystem services in ACC – and downstream!

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Photo: P. Bumpers

Upper Oconee stream health and ecosystem services. How are we doing? How could we improve?

1. Ecosystem services
2. Working condition of ecosystem services of UOW streams – Research results
3. How can capacity to provide services be improved?

http://www.freshwatersillustrated.org/Artist.asp?ArtistID=39742&Akey=3SWCG6TC

http://www.miseagrant.umich.edu/explore/coastal-communities/harmful-algal-blooms-in-the-great-lakes/

Streams and rivers provide important ecosystem services!

Physical/chemical/biological interactions that provide **high quality drinking water**

Support of **stream life and biodiversity**

Uptake and retention of nutrients to protect downstream ecosystems from algal blooms

How are Upper Oconee ecosystem services affected by watershed land use?

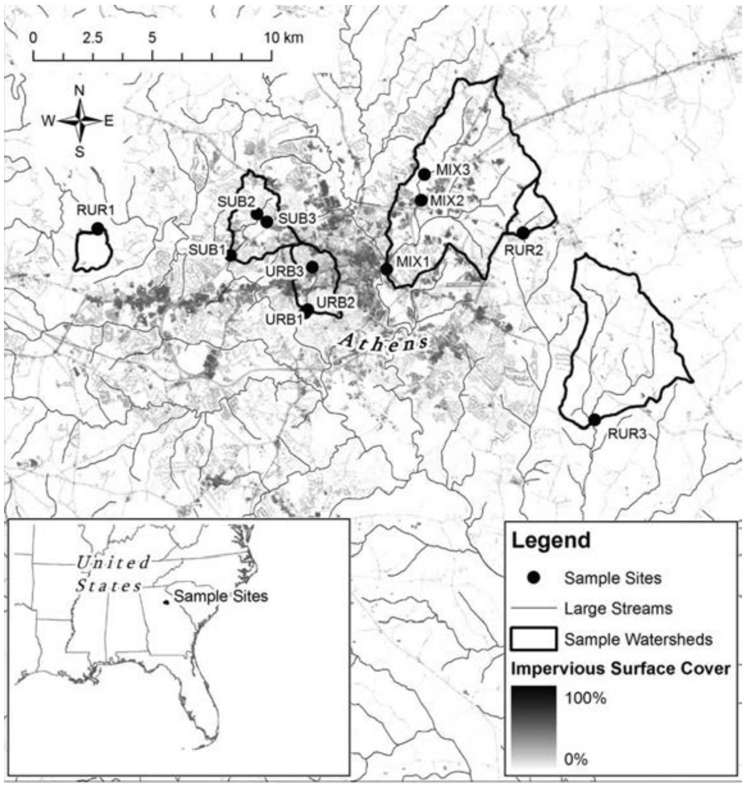
Stream biodiversity (biomass and # species) and watershed impervious surface cover

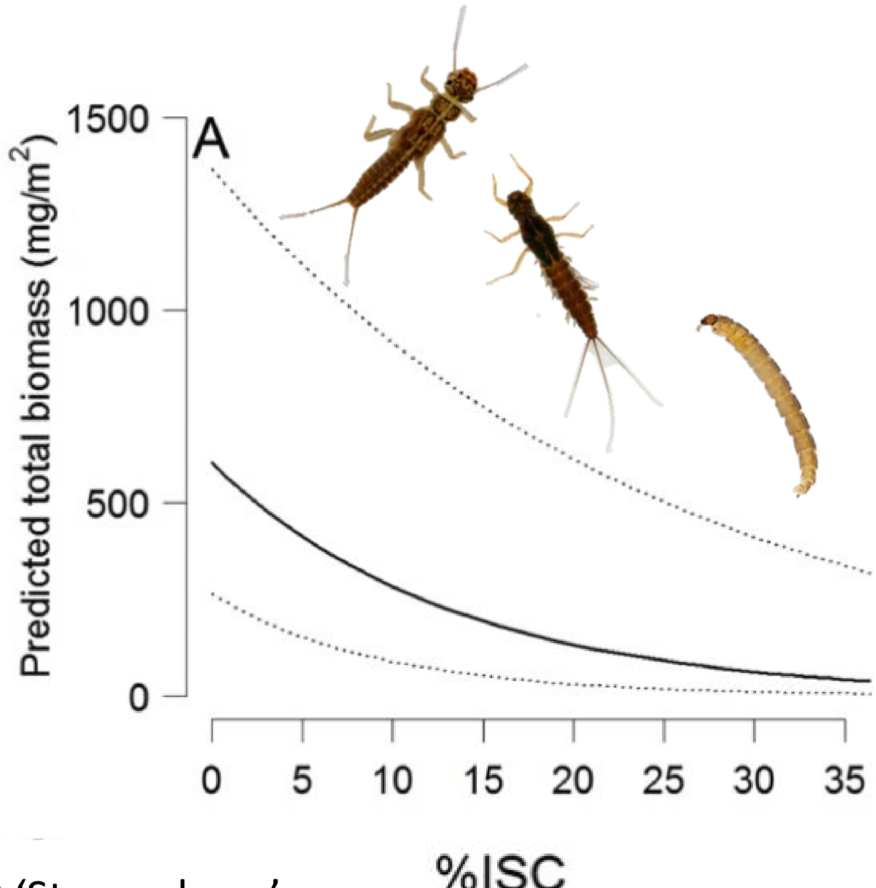
http://www.freshwatersillustrated.org/Artist.asp?ArtistID=39742&Akey=3SWCG6TC

Nutrient uptake capacity and watershed impervious surface cover / land use

http://www.miseagrant.umich.edu/explore/coastal-communities/harmful-algal-blooms-in-the-great-lakes/

↑ ISC,↓ Stream life





12 sites in UOW that ranged in ISC – 32,900 'Stream bugs' identified and measured. Each 1% ↑ ISC, 7% ↓ in biomass. Sterling, Rosemond and Wenger, 2016.

Sterling et al. 2016

↑ ISC, ↓ Stream life

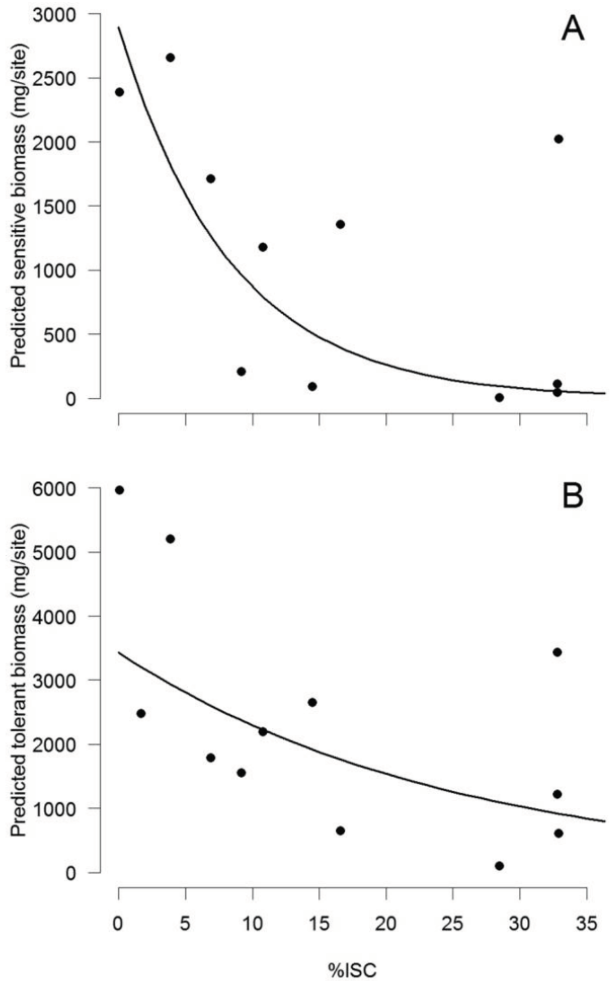


Figure 4. Linear regression models for the predicted biomass of sensitive (A) and tolerant (B) macroinvertebrates as a function of % impervious surface cover (ISC). Macroinvertebrate biomass was log(x)-transformed before analysis.

Sensitive taxa declined more precipitously than tolerant taxa.

This suggests **<u>both altered hydrology and pollution</u>** have negative effects on UOW stream organisms.

(Altered hydrology because both declined – pollution because sensitive declined more)

Number of species: 28 vs 16 at rural to urban sites.

Sterling et al. 2016

Stream nutrient uptake important for downstream lakes

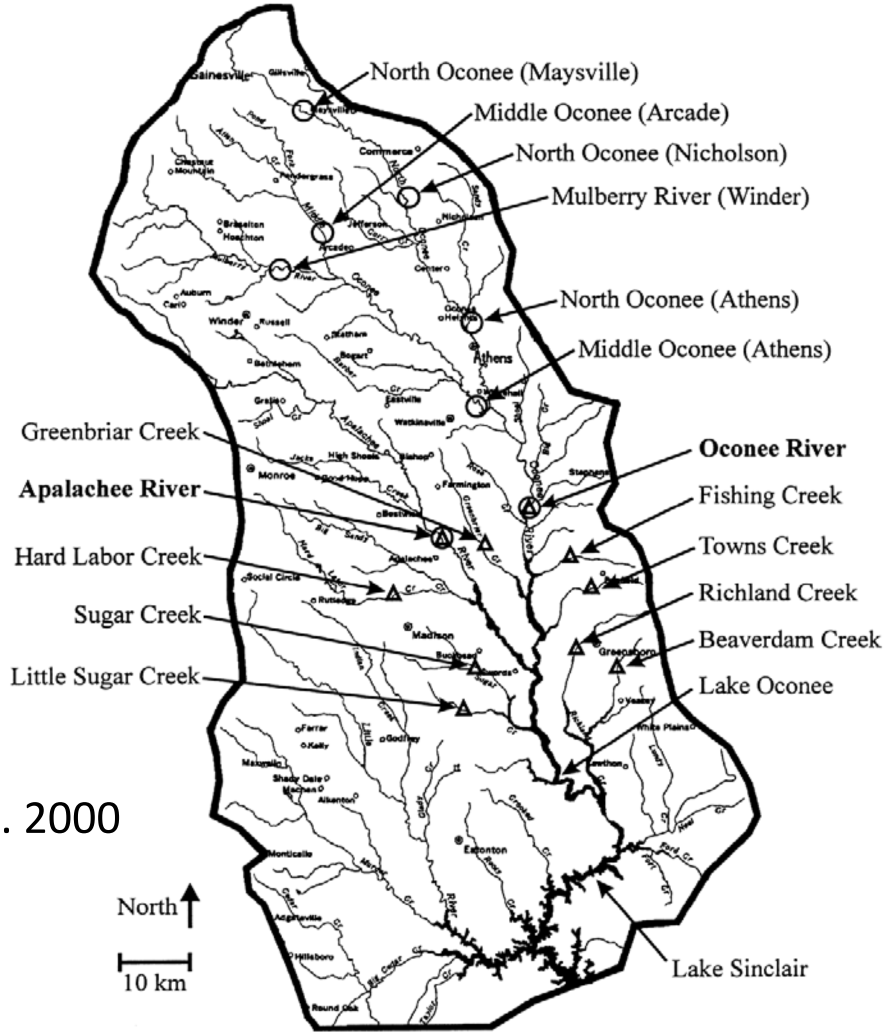
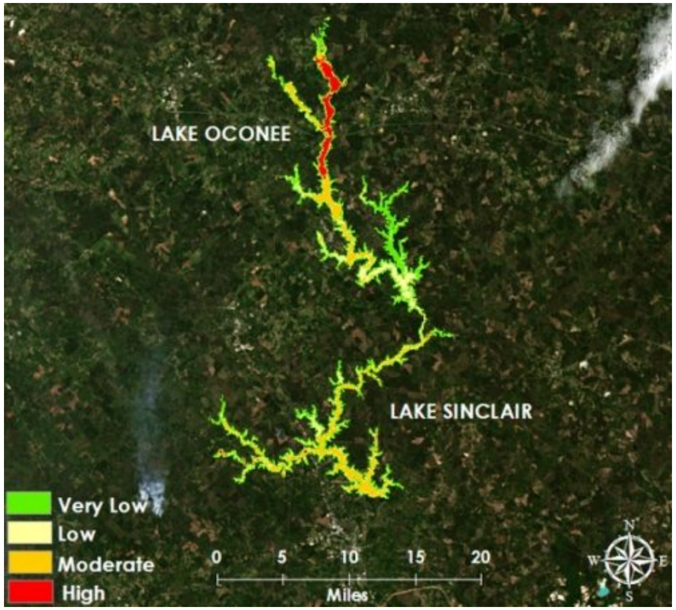


Fig. 1. The Upper Oconee Watershed of Georgia, USA, with selected sampling sites from Georgia Environmental Protection Division (circles) and Georgia Power (triangles) databases.

Fisher et al. 2000



https://earthzine.org/2014/11/23/the-bloom-gloom-monitoring-cyanobacteria-in-georgias-lakes/

Map shows Phycocyanin concentration (indicating cyanobacteria – algae that potentially cause water quality problems); Dr. Deepak Mishra, Dr. Susan Wilde, Advisors.

Previous study shows ↑ N and P downstream of Athens

Table 1

Annual means of monthly water quality samples from 8 sites in the Upper Oconee Watershed, Georgia, sampled once a month in 1996 ($n = 12$) (Data from EPA STORET)

Sampling site	Turbidity (Hach)	P (mg/l)	N (mg/l)	Fecal coliforms (MPN/100 ml)[a]
North Oconee (Maysville)	27 a	0.080 ab	0.86 ab	1270 a
North Oconee (Nicholson)	22 a	0.050 c	0.58 d	439 bc
North Oconee (Athens)	23 a	0.048 cd	0.53 d	613 abc
Middle Oconee (Arcade)	27 a	0.048 cd	0.85 ab	916 ab
Middle Oconee (Athens)	25 a	0.041 cd	0.78 bc	427 bc
Mulberry River (Winder)	28 a	0.060 bc	0.79 abc	791 abc
Oconee River	24 a	0.092 a	0.96 a	639 abc
Apalachee River	14 b	0.030 d	0.67 cd	364 c

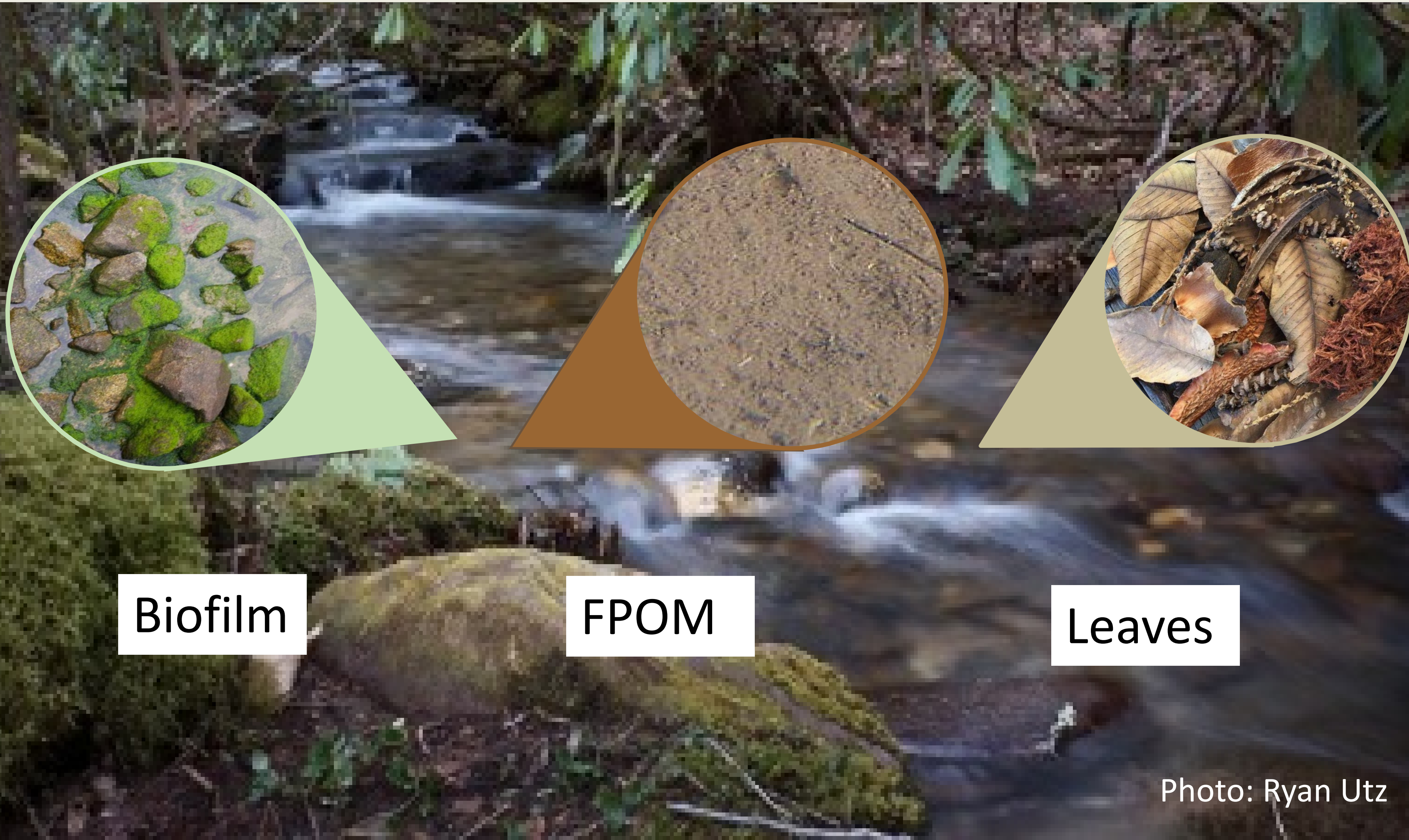
Fig. 1. The Upper Oconee Watershed of Georgia, USA, with selected sampling sites from Georgia Environmental Protection Division (circles) and Georgia Power (triangles) databases.

P doubles (2x)

N increases by 1.2-1.8x

Fisher et al. 2000

Nutrient retention occurs by microbes associated with biofilm, FPOM, leaves

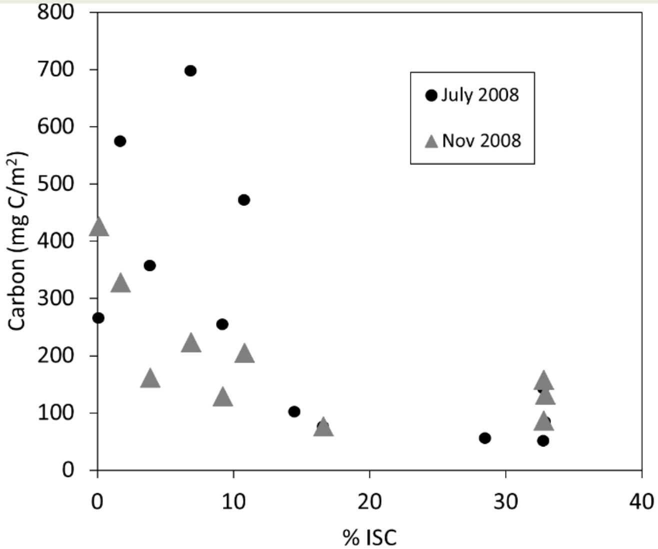


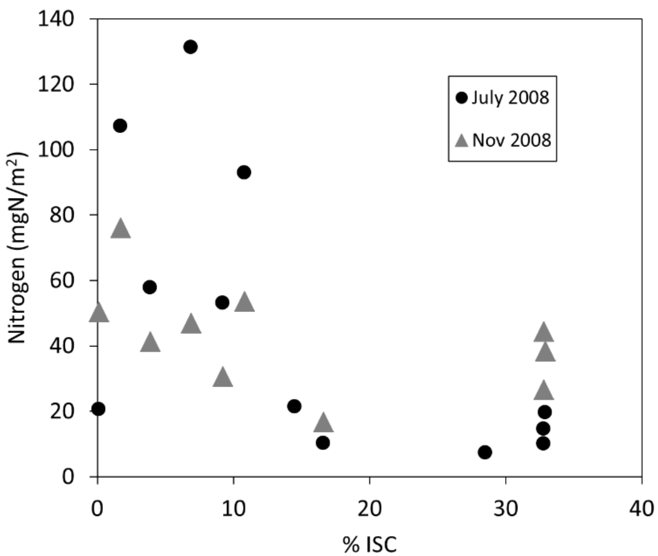
Measured Carbon & Nitrogen retention in biofilms and FPOM

http://www.phillywatersheds.org/what_were_doing/waterways_assessment/algae

Sterling, Rosemond unpublished data

↑ ISC,↓ Carbon & Nitrogen retention





12 sites, 2 seasons. Quantified biofilm and FPOM. Determined C and N content of each and scaled by % cover of that substrate (biofilm or FPOM) in each stream.

Each 5% ↑ ISC, 21% ↓ Carbon, 17% ↓ Nitrogen.

Sterling, Rosemond unpublished data

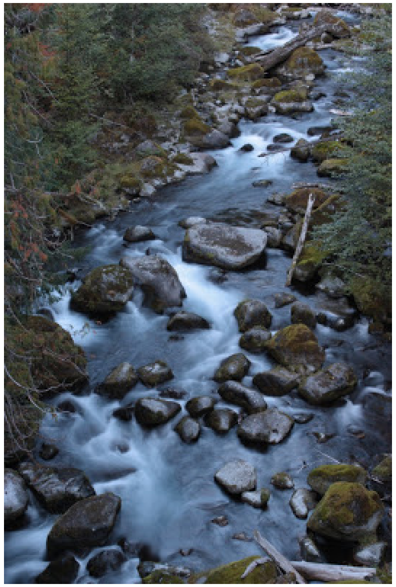
Summary: Watershed land use effects on Upper Oconee streams

1. ↑ Watershed ISC ↓ biomass of stream life and↓ number of species. Altered hydrology and pollutants implicated.

2. ↑ Watershed ISC ↓ retention of C and N. This reduces capacity for production of stream life (which is based on carbon), and suggests that at high ISC, nutrients are mobilized down stream.

Solutions: We can improve ecosystem services in 'working' streams

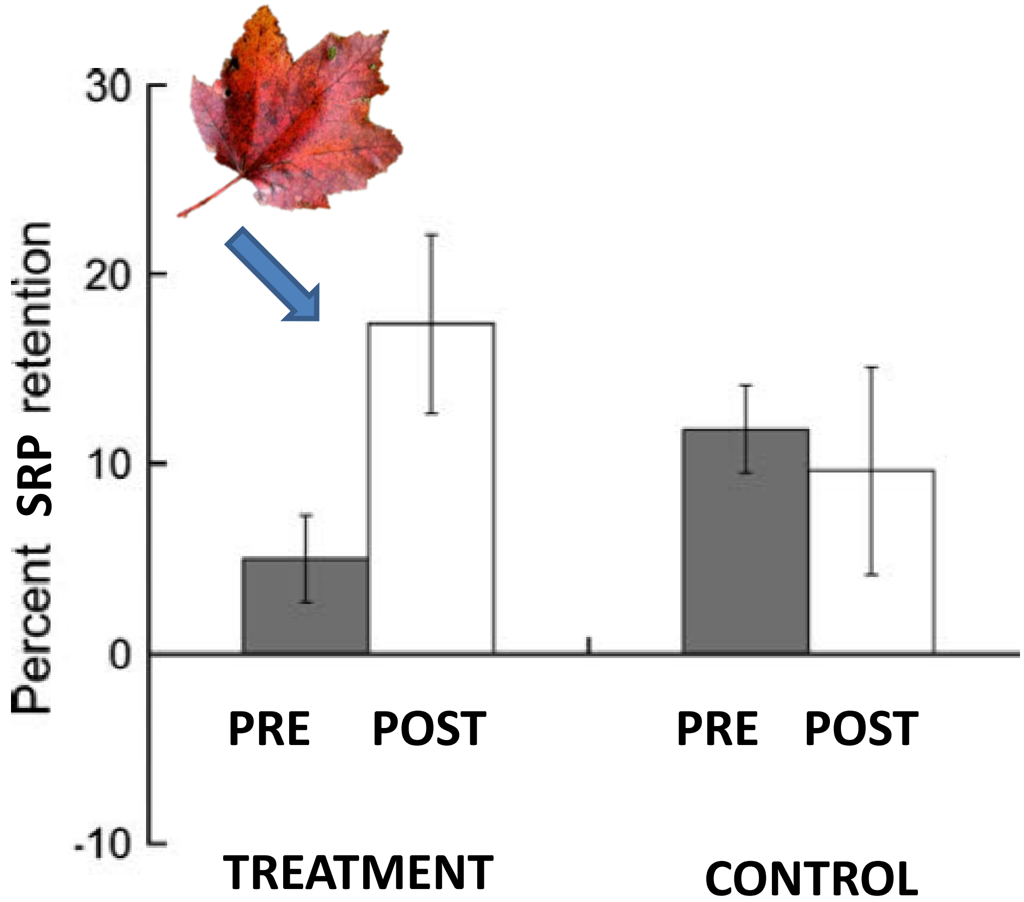
1. Solutions are in our hands – Control quantity and quality of storm-water and runoff; reduce demand (green infrastructure, conservation, water reuse).
2. Reduce nutrient loading. Streams can only retain and process 'so much' – we need tighter controls on WWTP to protect water quality in Lake Oconee (harvest P for fertilizer?).



http://journeywithstevenmichael.blogspot.com

3. Protect and expand riparian buffers. We can improve the capacity of streams to support life, be resilient to climate change, and retain nutrients by improving riparian tree and vegetation cover.

Solutions: Restoration example; add leaves, ↑P uptake



Studies in our lab show that high concentrations of N and P of streams reduce these substrates

~ 20 g/m2 added to TREATMENT stream compared to CONTROL; Aldridge et al. 2009

Solutions: Streamside vegetation cools streams + provides carbon for production of stream life and retention of nutrients

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