Baltimore Ecosytem Study Quarterly Research Meeting

Topic: Synthesis updates

July 1, 2020

Welcome - Emma J. Rosi, Project Director

Notes:

- We have a large number of presentations into a short time-frame
- We have built in three discussion times, please limit discussion and questions until those breaks
- Everyone but the speaker and the host should be muted except for the discussion times.
- Please use the chat box liberally throughout the talks to share any comments or questions that you may have
- We have not built in any breaks, so feel free to step away from zoom if you need a break during the meeting

Change in the Trees: evaluating canopy and diversity changes using iTree data.

Elsa Anderson, Cary Institute

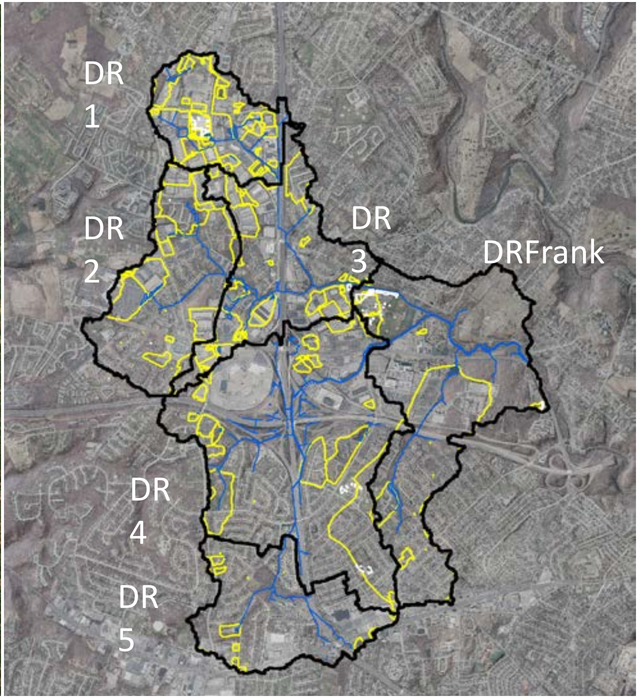
VIDEO

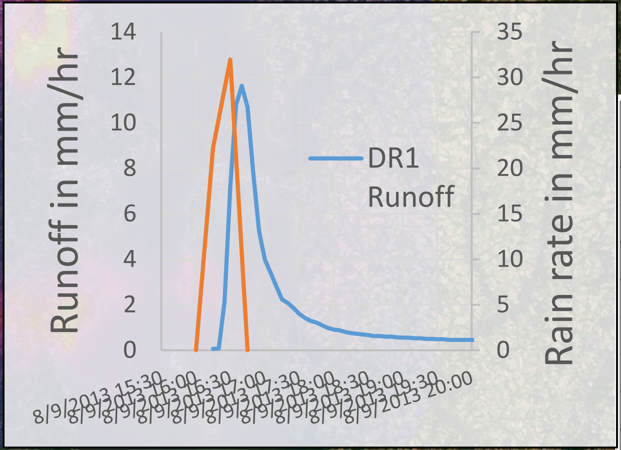
Paired-watershed comparisons to assess effectiveness of traditional stormwater management.

Andy Miller, University of Maryland, Baltimore County (UMBC)

Application of long-term radar rainfall and streamflow data in assessing runoff response to varying impervious cover and SWM

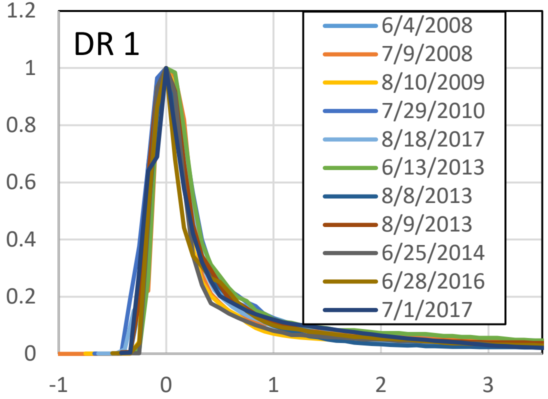
Andy Miller, UMBC
BES July 2020 Quarterly Meeting

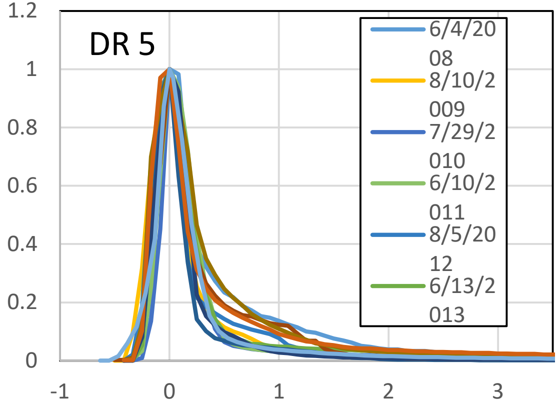




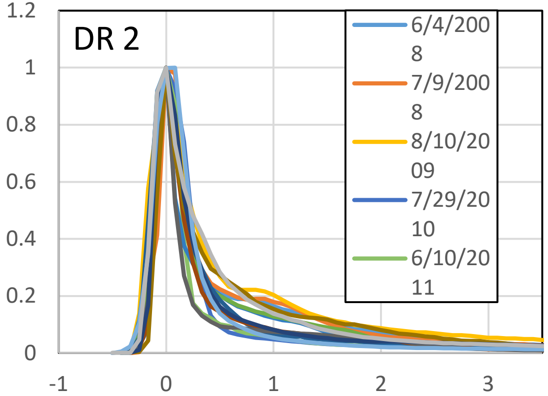
Watershed	Drainage Area (km²)	% Impervious Cover	% Draining to SWM
DR1	1.19	67.0	61.1
DR2	1.92	49.1	33.0
DR5	1.63	45.9	2.7
DR3	5.08	55.2	42.1
DR4	5.84	47.8	10.2
DRFrank	14.2	46.4	32.3

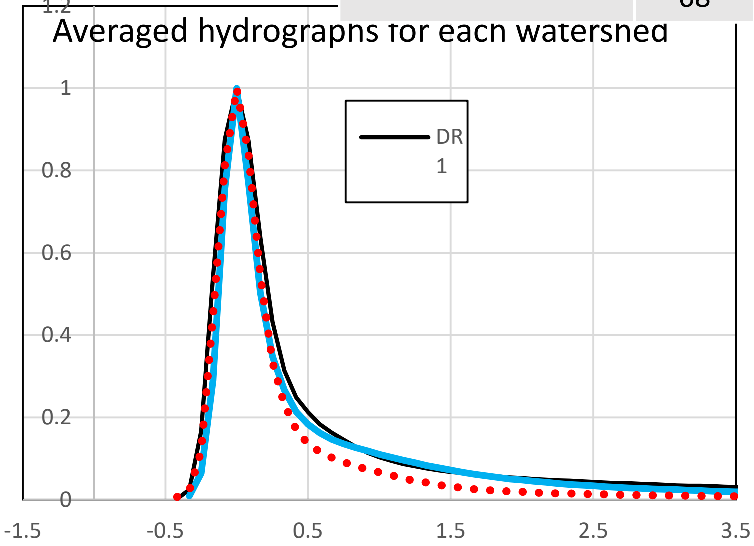
Acknowledgements:
Claire Welty, UMBC
Jim Smith and Mary Lynn Baeck, Princeton
NSF and Chesapeake Bay Trust





Watershed	DR1	DR2	DR5
Drainage area (km^2)	1.19	1.92	1.63
Precip total (mm)	9-32	7-34	9-41
Max 15-min intensity (mm/hr)	26-73	12-80	22-90
Time of rise (min)	15-30	15-35	20-30
Time to 10% of peak Average	50- 120 68	30-110 70	25-75 45

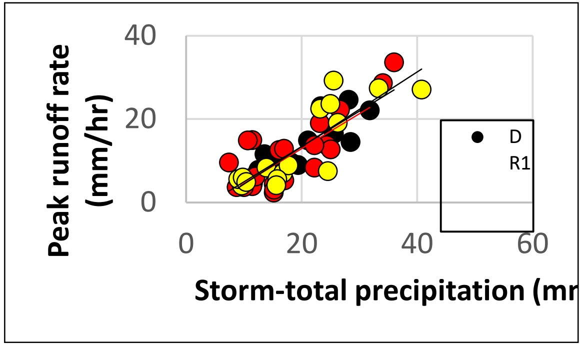


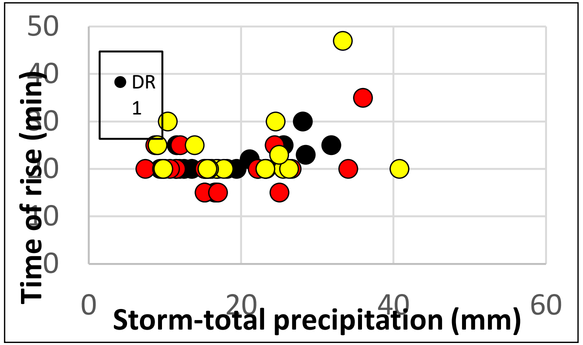


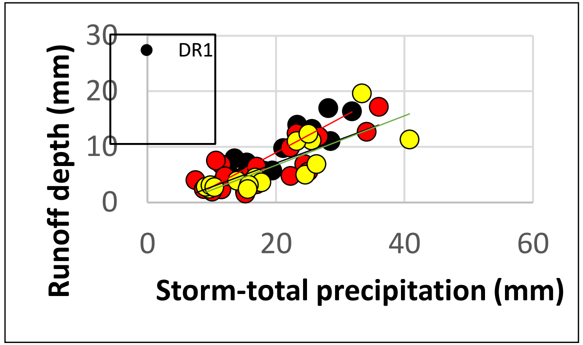
All hydrographs normalized by magnitude of peak flow with time in hours centered on peak flow

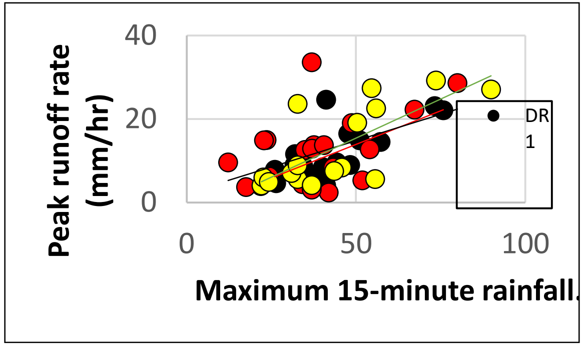
All events had >99% of precipitation in <= 1 hour

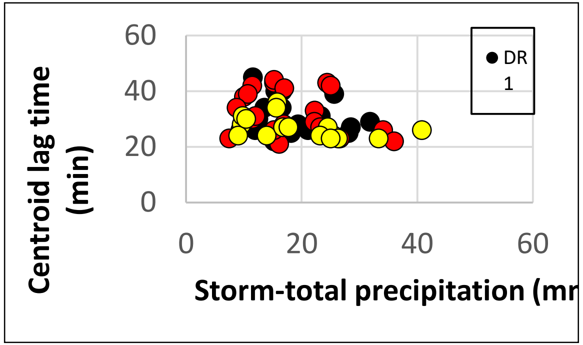
No baseflow separation and no other corrections

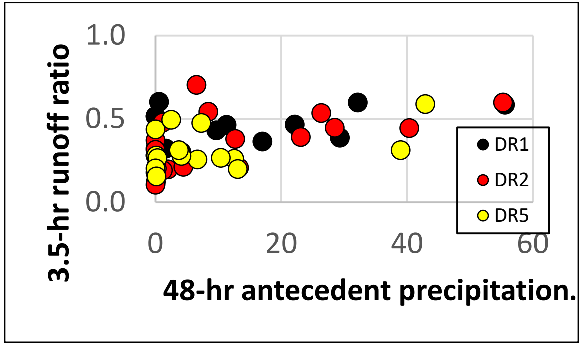












No clear difference between rainfall-peak runoff trends

Storm-total precip a better predictor than max intensity

With few exceptions, time of rise tightly clustered around 15-25 min

DR5 tends to have shorter centroid lag times – differences between watersheds most apparent on falling limb of hydrograph

DR1 has steeper runoff volume response to rainfall compared with DR2 and DR5

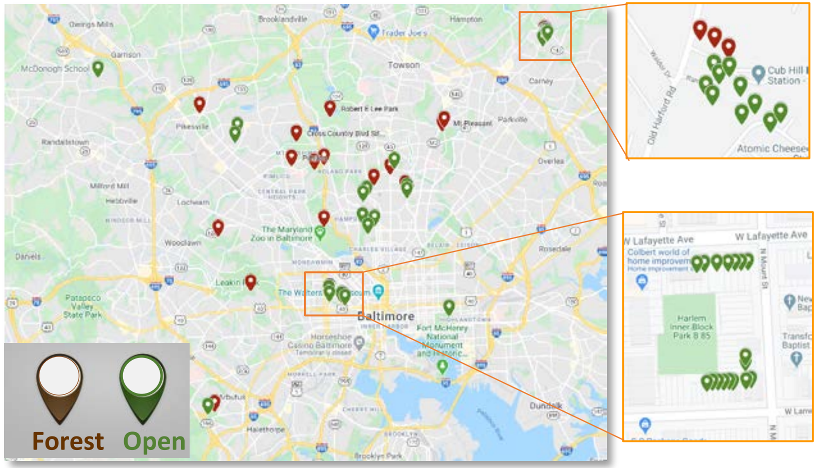
Antecedent moisture is weakly related to runoff ratio

Earthworm diversity in the urban landscape: Combining data from different sampling campaigns.

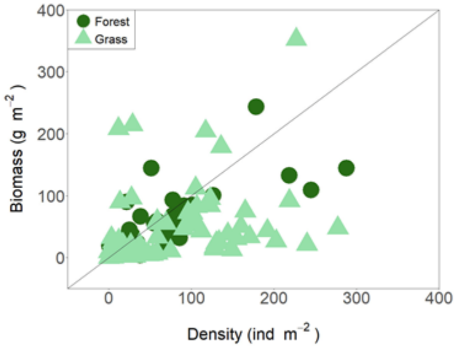
Kathy Szlavecz, Johns Hopkins University

Earthworm diversity in the urban landscape

Many thanks to Yinhong Hu and all the helping hands in the field!



- >70 parcels
- > 600 samples
- > 8000 specimens ID-d
- Number, biomass
- Mustard extraction

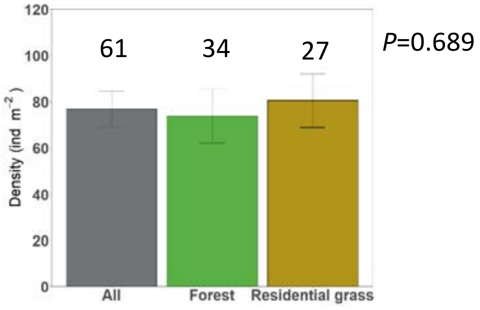


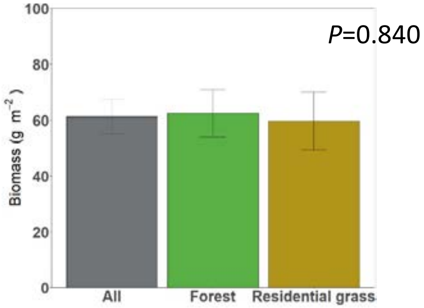
Q1: Is earthworm community composition and abundance different in wooded (remnant forests, parks) and open (residential lawns, other grassy areas) areas?

Q2: How stable are earthworm communities?

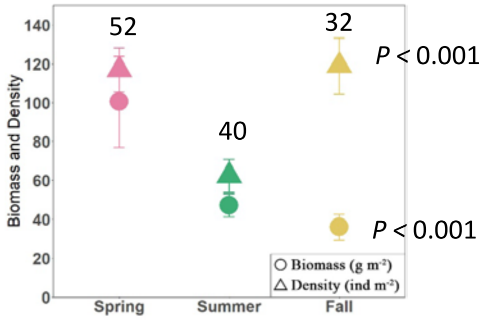
Q1: Comparison of wooded and grass

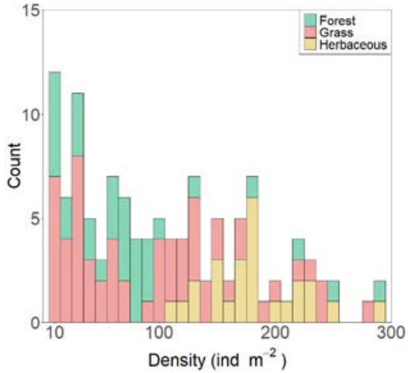
1. Mean abundance is not different …..



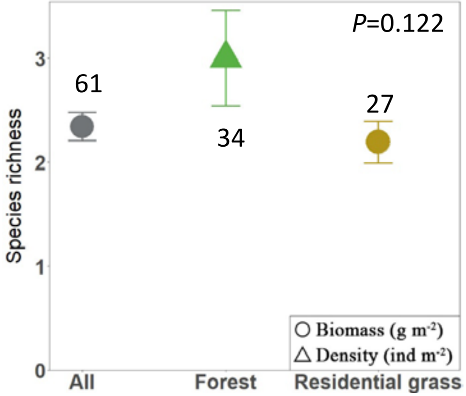


….but varies with season ………………………..and cover





2. Mean species richness per parcel is low



Species pool: 38 (15 native + 23 non-native)

In urban: 17 (2+15)

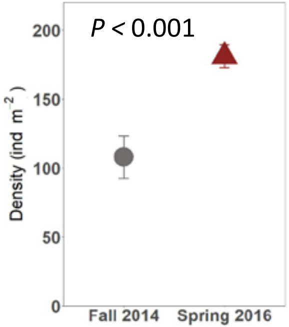
Q2: Change over time

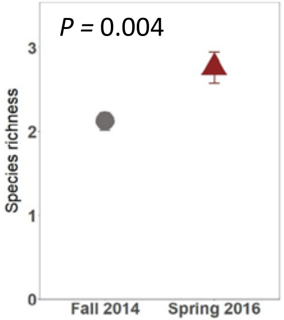
1. Vacant lots

2013

2016

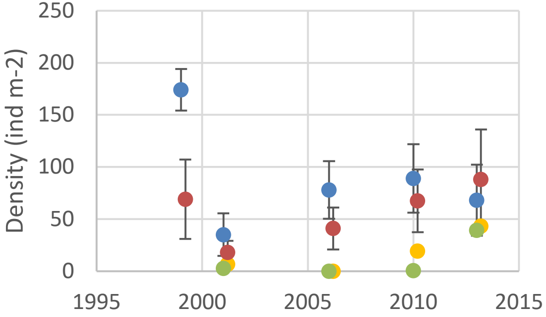
Both abundance and species richness increased





N=25

2. Permanent forest plots



Urban: Leakin Park
Reference: Oregon Ridge
Fall sampling only

All earthworms - urban
All earthworms – reference

Jumping worms – urban
Jumping worms – reference

3. U-R forest fragments

2002: Sampling of 15 stands
2020: TBD

Resilience and memory of watershed discharge and nutrient loading to hydroclimate extremes.

Larry Band, University of Virginia

Resilience and memory of watershed discharge and nutrient loading

L Band, L Lin, J Duncan, P Groffman, Neely Law, Naomi Tague, Steve Kenworthy, …

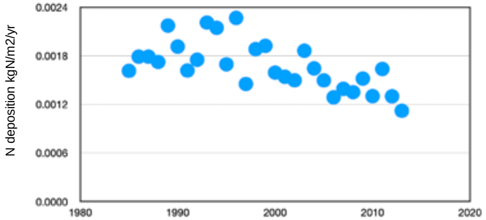
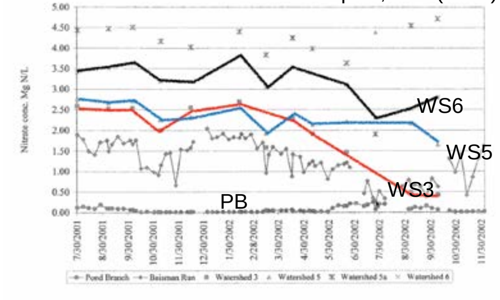
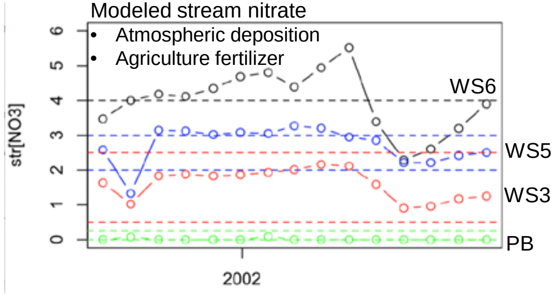


Figure 4.2. Time series of nitrate-N concentrations for Pond Branch, Baisman Run and the subwatersheds.

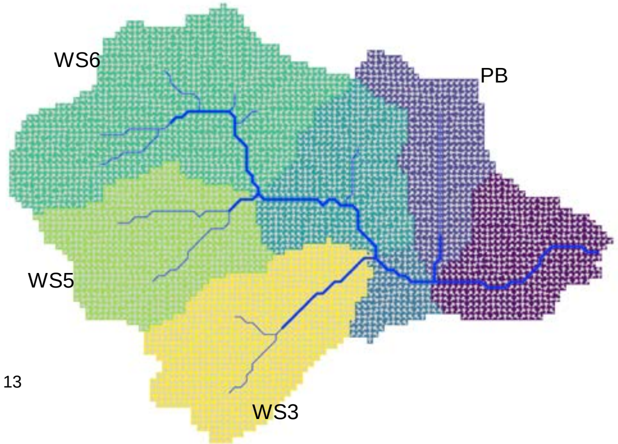
Subcatchment stream nitrate samples, Law (2004)



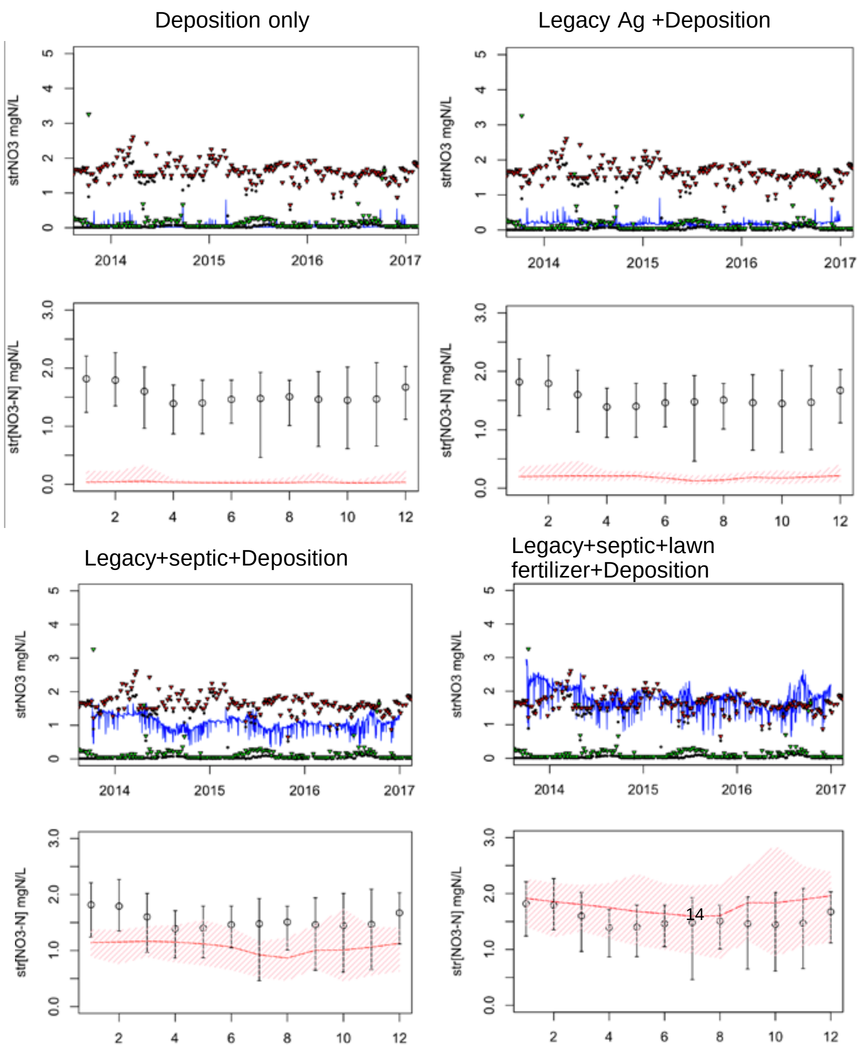


Baisman Run N loading response to major drought 2002 – driest year on record

1. **atmospheric deposition**
2. **legacy pollution in GW**
3. **septic N load**
4. **Dogs**



Baisman Run subcatchments



Contextualize role of current and legacy (agricultural) sources of N in streamflow

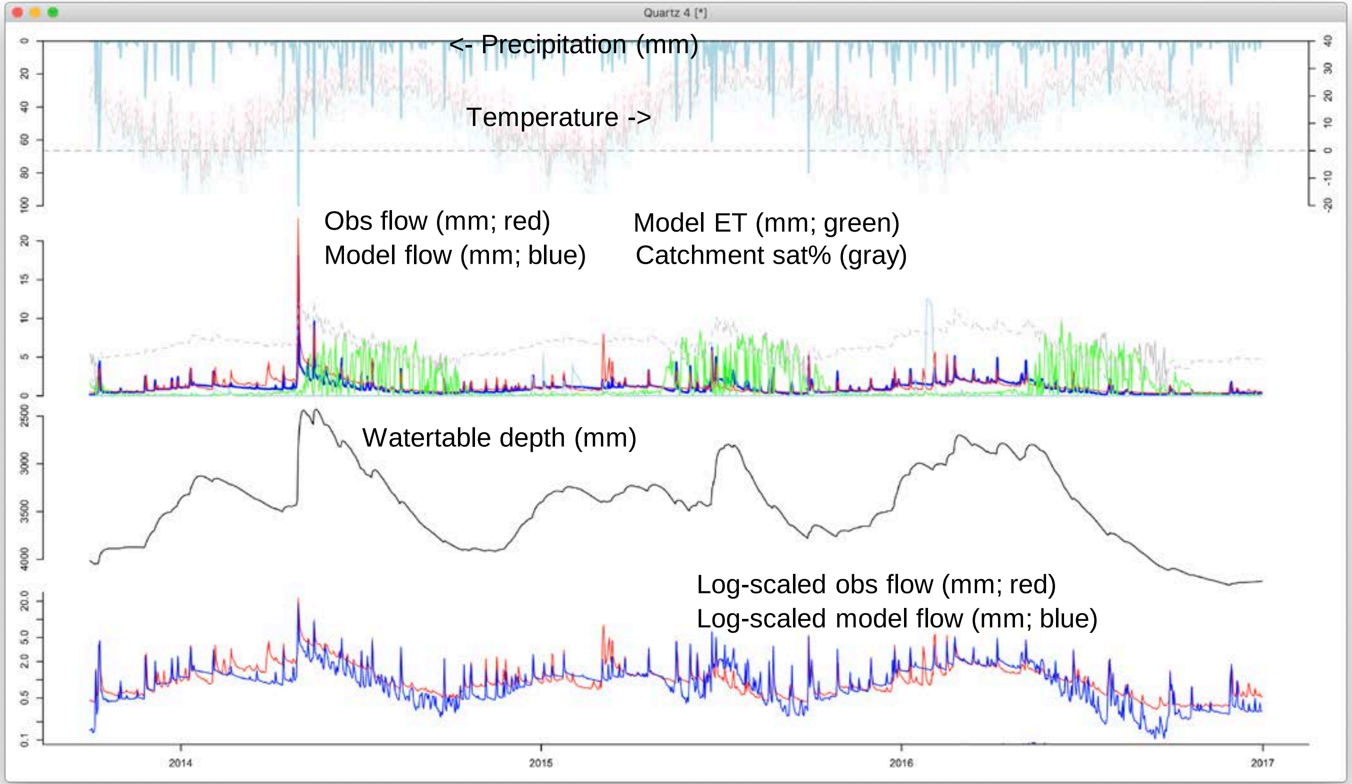
Factorial design for numerical experiments: Successively add estimated N sources

1. **atmospheric deposition**
2. **legacy pollution in GW**
3. **septic N load**
4. **Dogs**

▼ Baisman str [TN] (mgN/L)
● Baisman str [NO_3-N] (mgN/L)

▼ Pond Branch str [TN]
● Pond Branch str [NO_3-N]

(daily) Modeled Baisman str [NO_3-N]
(seasonal) Modeled Baisman str [NO_3-N]



Baisman Run (30m) growth simulation

dailyNSE	dailyLogNSE	meanAnnualFlashObs	meanAnnualFlashRHESSys	weeklyNSE
0.69	0.46	0.21	0.29	0.68
weeklyLogNSE	inversedweeklyNSE	weeklyCDFfitr2	monthlyNSE	monthlySAE
0.57	-0.91	0.90	0.65	9.41
yearlyNSE	yearlySAE	bias	wbias	sbias
0.62	59.16	0.15	0.02	-0.09
totPrecip	totET	totFlow	totFlowObs	RHESSysRunoffRatio
3292.54	1688.96	1290.70	1476.75	0.36
obsRunoffRatio	ETbias	flashCOMP	loglikelihood	maxLAI
0.42	-0.07	0.08	-5.30	3.27

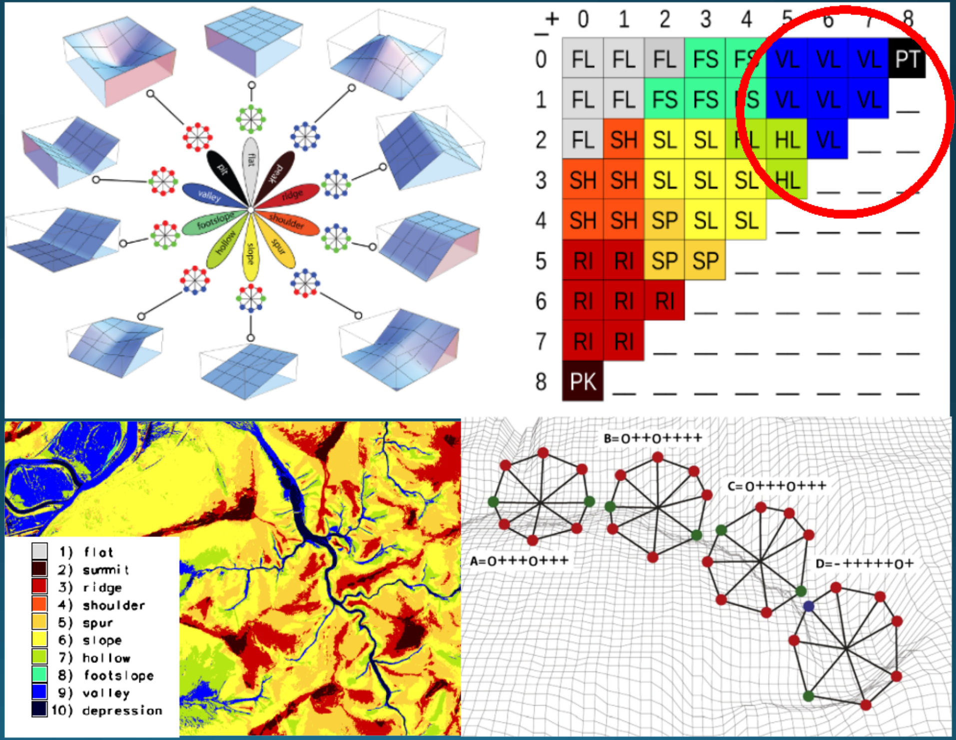
Watershed-scale mapping of channel incision across drainage network scales using Geomorphon and airborne LiDAR.

Matt Baker, UMBC

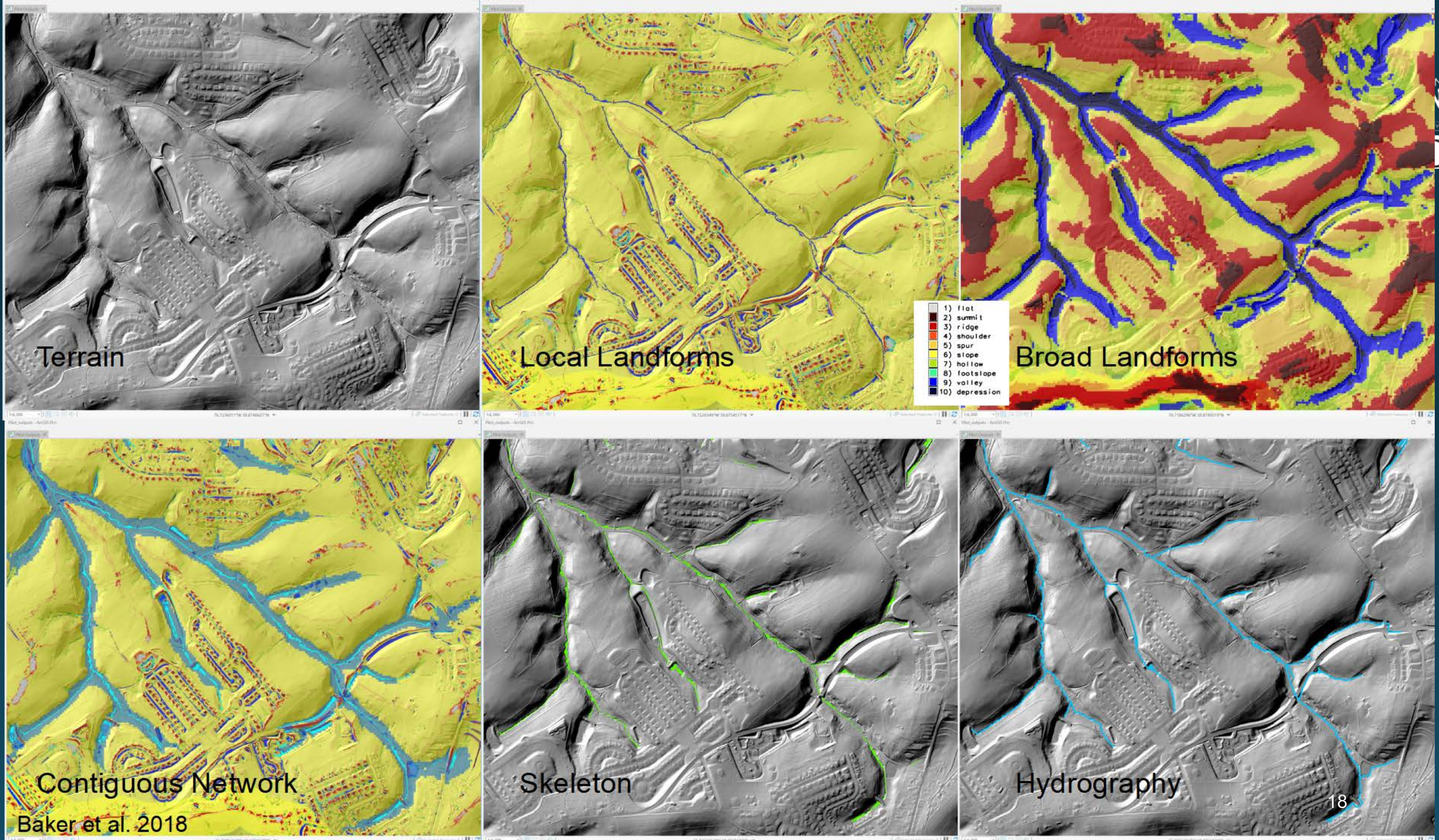
Bank height estimation from terrain-based hydrography

Matthew Baker, Andy Miller, Santiago Munevar, David Saavedra – July 2020

- Landform classification algorithm by Jasiewicz & Stepinski (2013)
- Uses a search radius to assess line-of-sight in 8 directions
- Evaluates the directional position and relative elevation to determine scale-independent landform: *geomorphon*
- Aggregates combinations of high, low, and equal elevations into 10 most common landforms
- We focus on concave depressions (e.g., 'valleys' and 'pits') to delineate stream channels



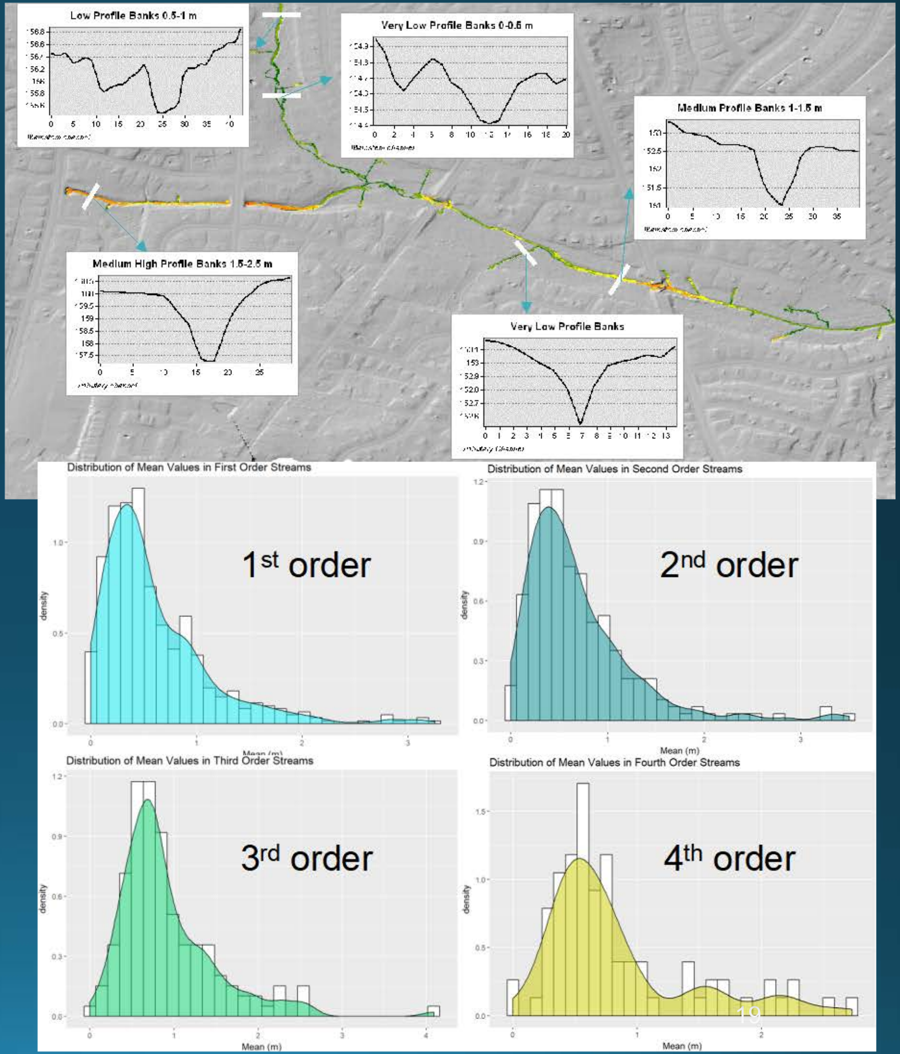
Baker et al. 2018



Baker et al. 2018

Hyper-res Streams

- Geometric characteristics derived for every pixel in network
  - Bank height
  - Channel width
  - Valley/Floodplain dimensions
- Summarized (mean, SD) locally or at reach scale in polyline network
- Robust: 10^1 of observations for each cross section, 10^2 to 10^3 for reaches
- Graphs at right depict cross-sections from GF at Scotts Level and distributions of bank height for 1st through 4th order channels in the GF.
- Valuable information for:
  - mapping incision, flow routing
  - targeting restoration, reconnection
  - topographic shading for stream metabolism, etc.

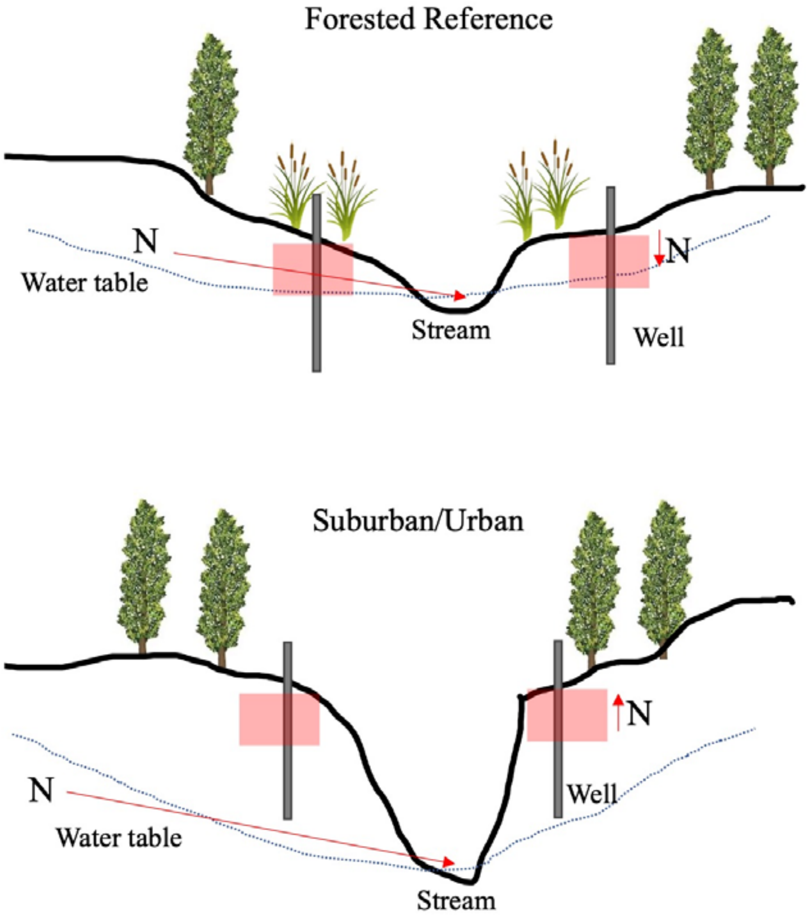


Q&A – section 1

Moderator - Emma Rosi

Long-term data on riparian water tables yields insight into the local land use and climate controls on terrestrial and stream interactions.

Amanda Suchy, Cary Institute



Adapted from Groffman et al 2003

Long term data on riparian wells

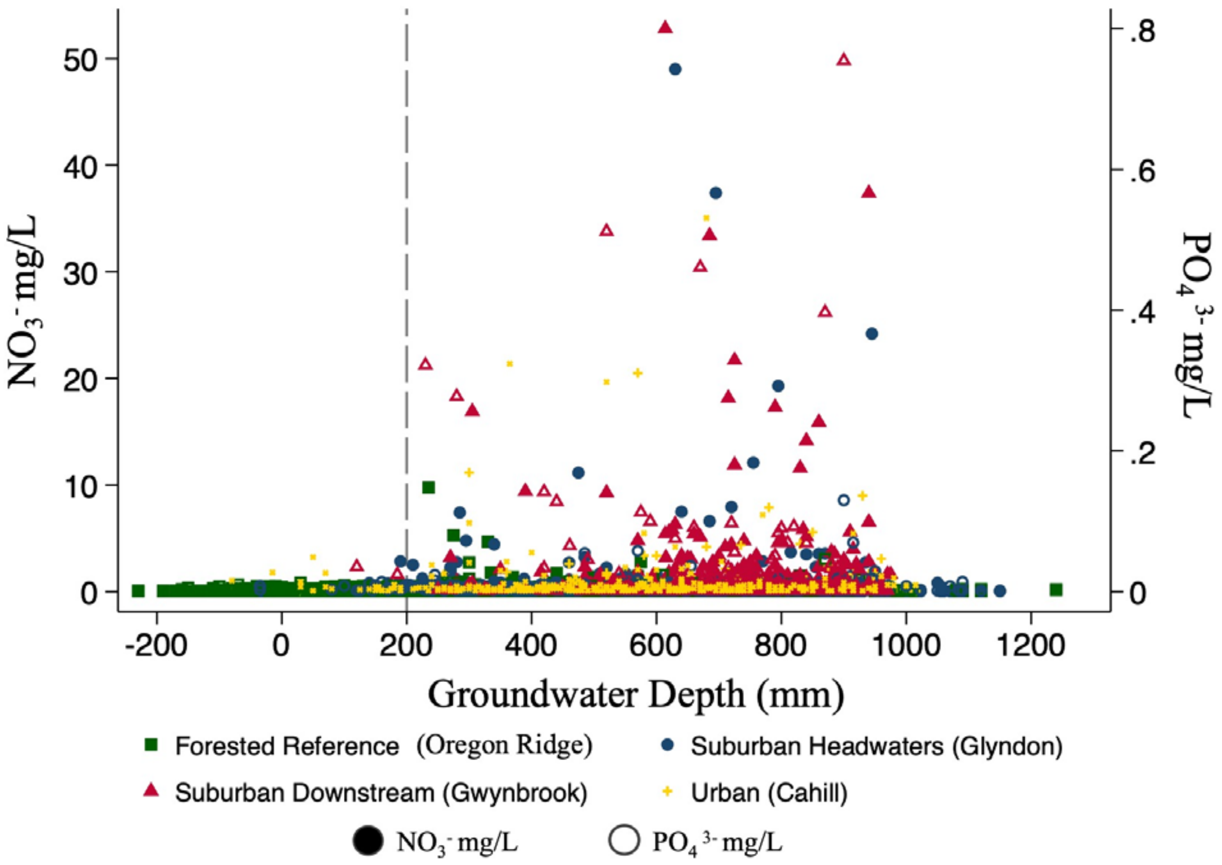
4 locations (forested ref, 2 suburban, urban)
1m depth
Sampled monthly
GW depth, NO_3^-, PO_4^-

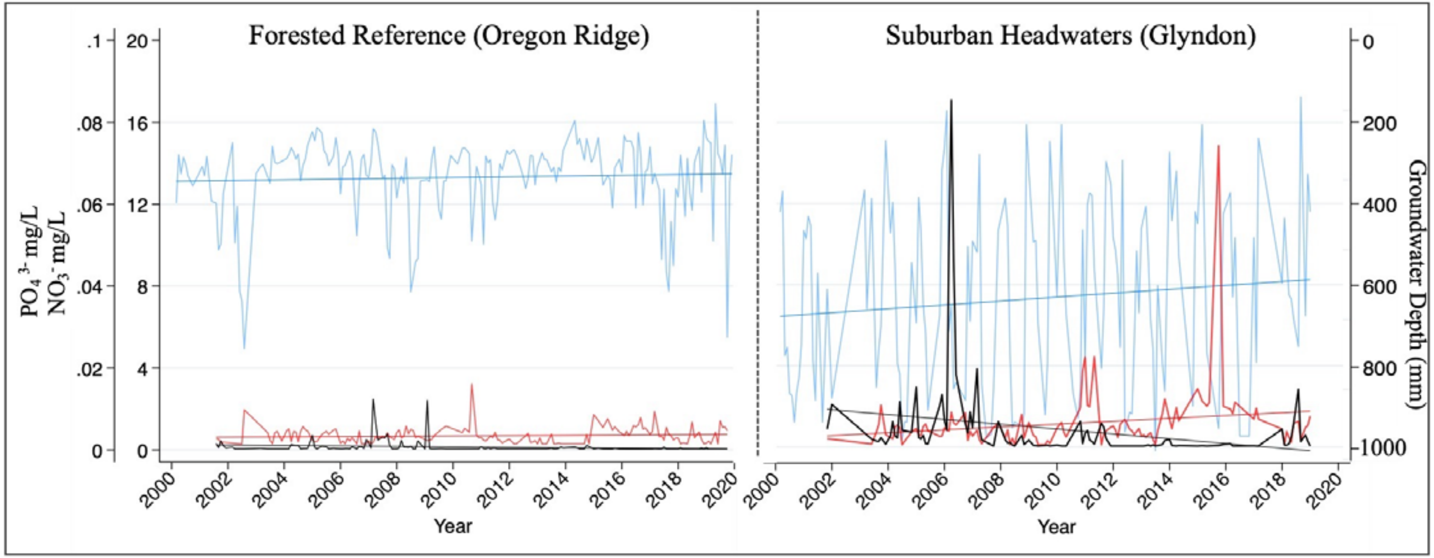
Is groundwater depth (ie connectivity) related to GW chemistry?

How are these properties changing over time?

What are driving these changes?

Highest concentrations of NO_3^- and PO_4^{3-} occur when groundwater depths are below 200mm





Over the past 20 years, we generally observe that:

- Groundwater ↑
- NO_3^- ↓
- PO_4^{3-} ↑

Why?

GW is getting shallower → NO_3^- decreasing

Increased connectivity

Increased precip?
Infrastructure repair?
Restoration?

Increased growing season?
Fertilizer restrictions?

Long-term patterns in nitrate leaching and nitrous oxide fluxes from lawns and urban and rural forests.

Peter Groffman, City University of New York (CUNY) and Cary Institute

Journal of Environmental Quality 38:1848-1860, 2009

Nitrate Leaching and Nitrous Oxide Flux in Urban Forests and Grasslands

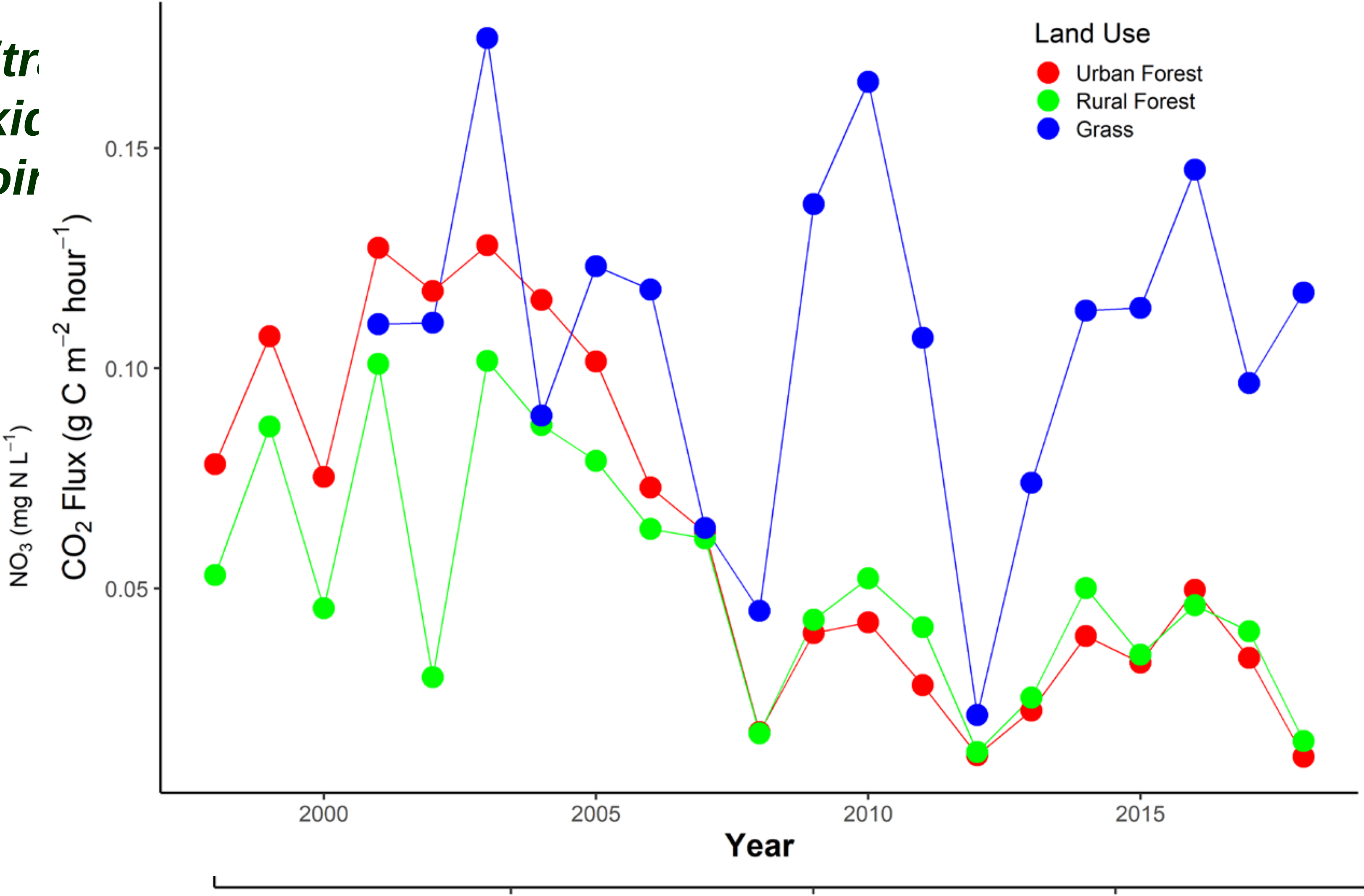
Peter M. Groffman* Cary Institute of Ecosystem Studies
Candiss O. Williams Purdue University
Richard V. Pouyat USDA Forest Service
Lawrence E. Band University of North Carolina
Ian D. Yesilonis USDA Forest Service

Surprising result that urban grasslands do not have super high nitrate leaching and nitrous oxide flux compared to forests.

Surprising (lack of) patterns with fertilizer input.

Appears to be linked to surprisingly high carbon cycling in grasslands that tightens up the nitrogen cycle.

Nitr ... us
oxid ... is
doi



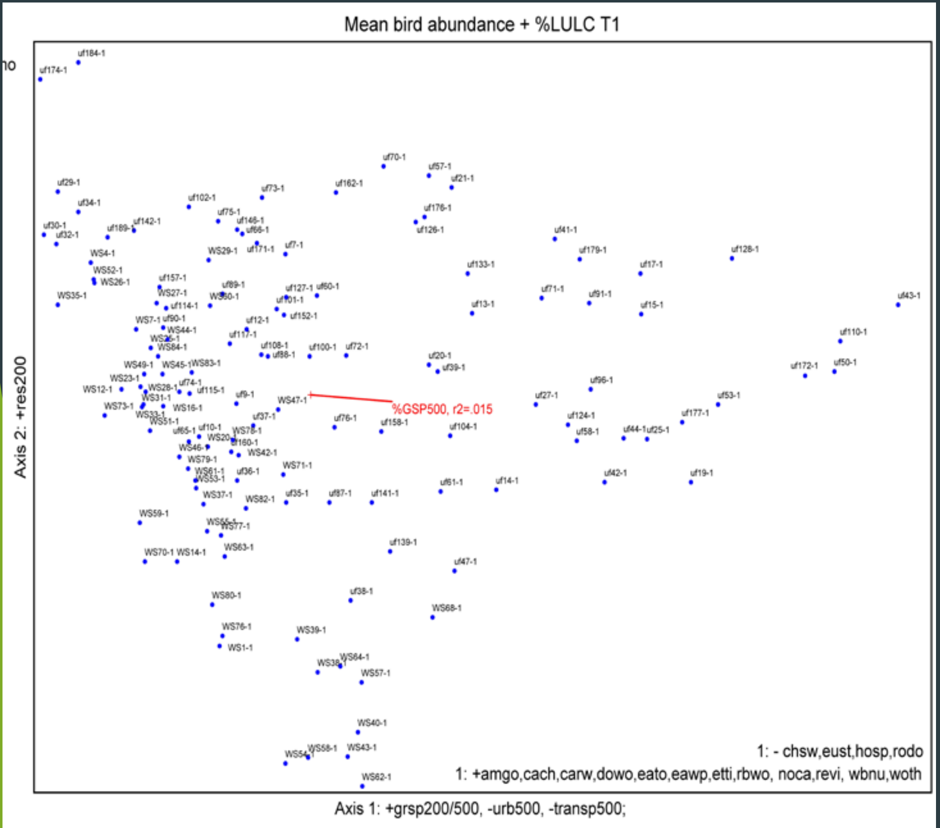
Nitrate patterns have become more clear and sensible, nitrous oxide still a mystery, fertilizer response still a mystery, carbon is doing something . . . .

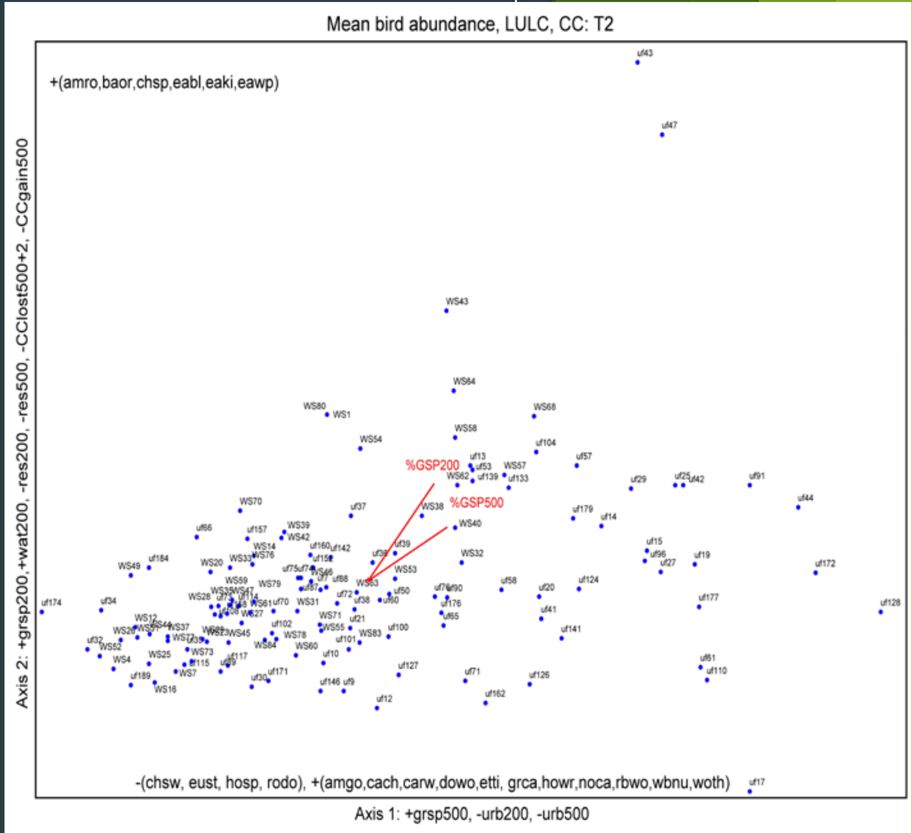
- Grasslands have more nitrate leaching than forests.
- Fertilized grasslands have more nitrate leaching than unfertilized grasslands (sort of, sometimes).
- Grasslands do NOT have higher nitrous oxide flux than forests.
- Fertilized grasslands do NOT have higher nitrous oxide flux than forests (*note that we have not sampled right after fertilizer application)*.
- *Is nitrous oxide flux driven more by atmospheric deposition/nitrogen oligotrophication than by fertilizer?*
- Carbon dioxide flux is high in grasslands, likely contributes to nitrogen retention.
- *Why is carbon dioxide flux going down in forests? An effect of mesophication and overgrazing?*

BES Bird Monitoring Project: Populations and Community Change Over Time.

Charlie Nilon and Ela-Sita Carpenter, University of Missouri

Bird Community Change 2005-2009 (T1) to 2012-2018 (T2)





Modeling Predictors of Species Abundance Hierarchical Modeling: Generalized Additive Model

- European starling
- House sparrow
- Chimney swift
- American robin
- Wood thrush
- Eastern wood peewee
- Mourning dove
- Common grackle
- Northern mockingbird
- Northern cardinal
- Gray catbird
- Tufted titmouse

Covariates

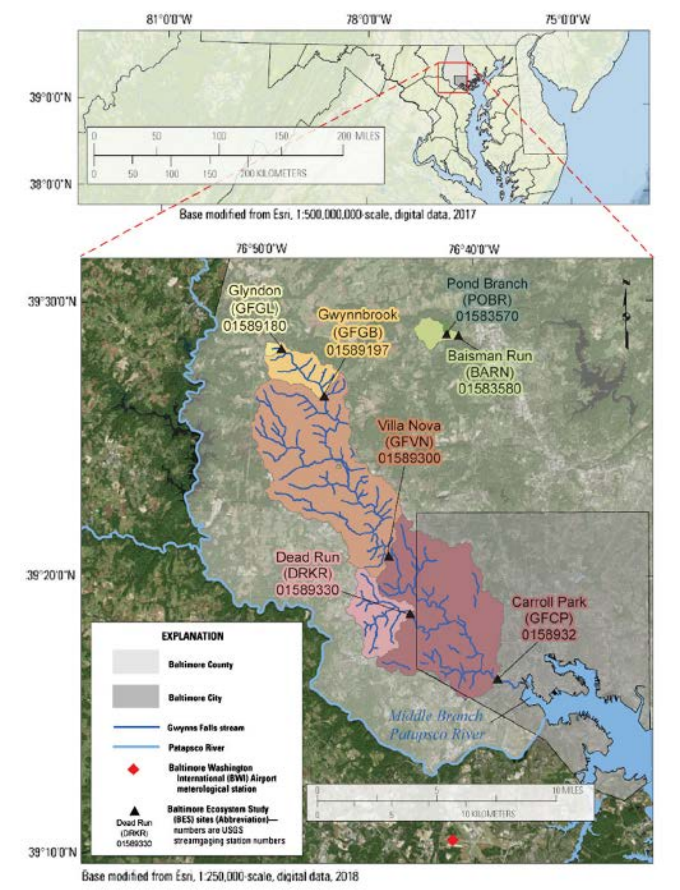
- Landuse/cover within 200m and 500 m radius
  - Residential
  - Greenspace
  - Transportation
- Itree plot data
  - Tree
  - Building
  - Mowed grass
- Tree Baltimore Canopy data 2007-2015 within 200 and 500 m radius
  - Canopy cover
- Census Track Block Group
  - Black
  - BS degree
  - Families w/ children <18
  - Public Assistance
  - Median year home built

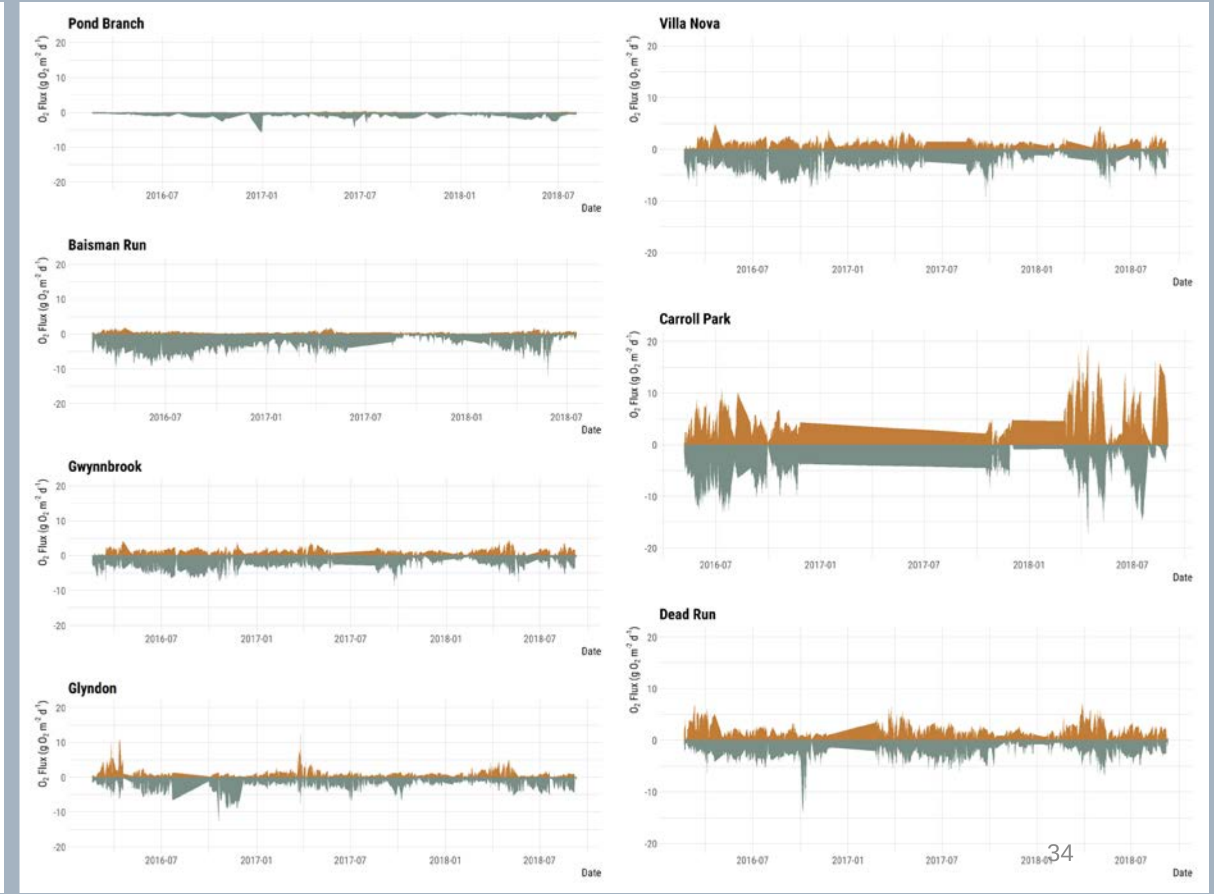
Variations in stream metabolic regimes along a rural-urban gradient reflect surrounding land-use.

A.J. Reisinger and Emily Taylor, University of Florida

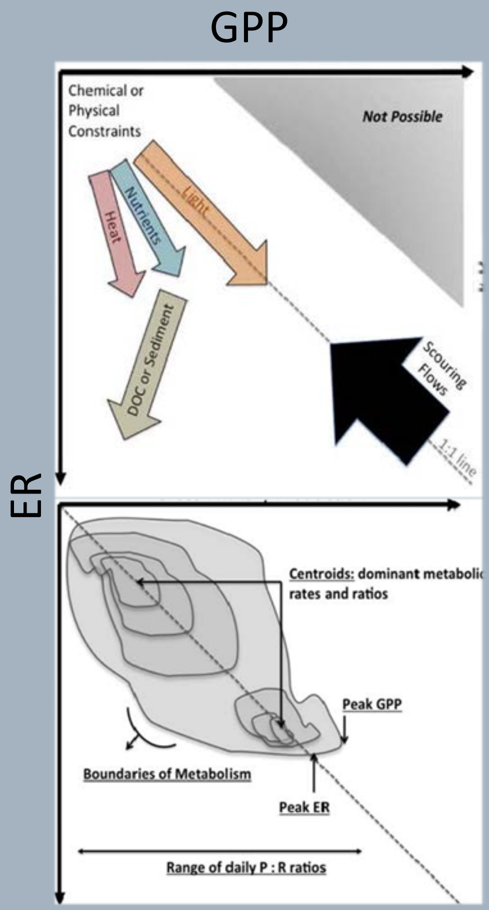
Stream metabolic regimes across an urbanization gradient

AJ Reisinger, Emily Taylor, Joanna R. Blaszczak, Matthew J. Cohen, and Emma J. Rosi

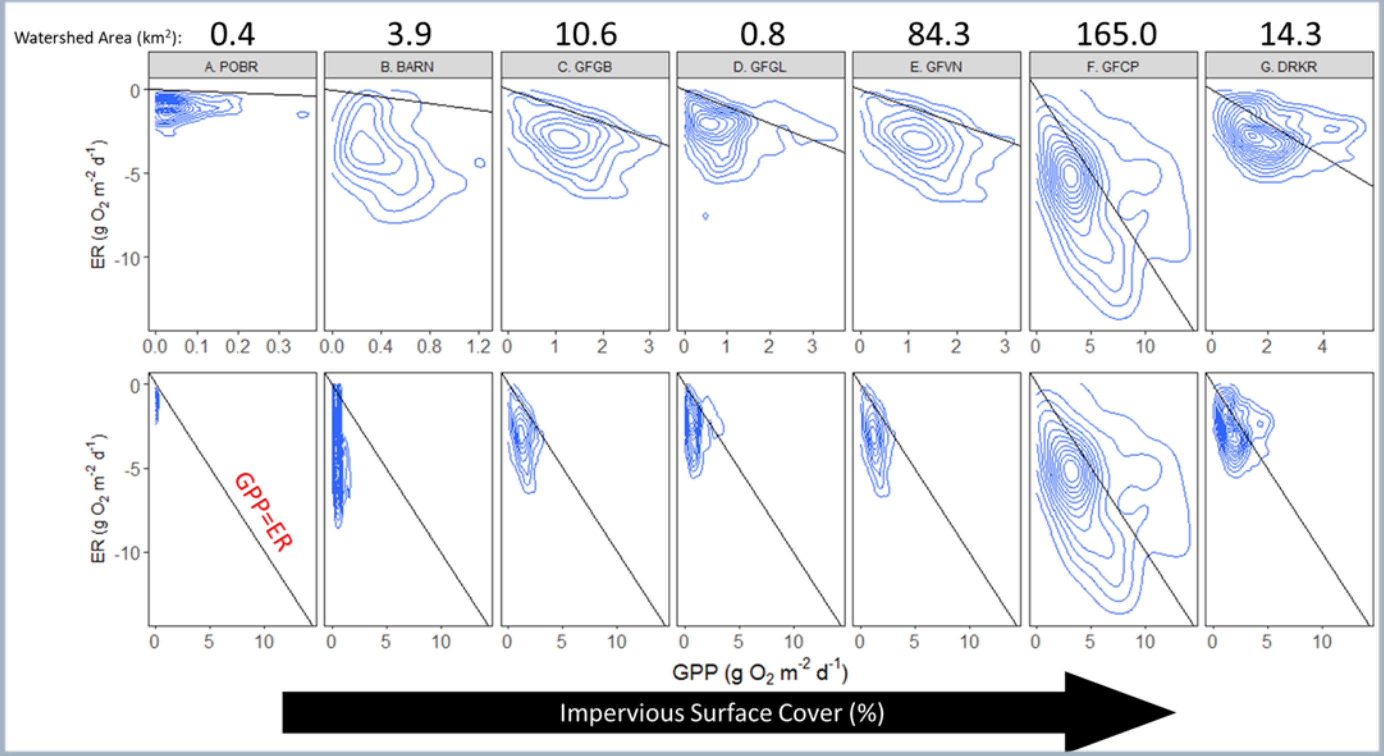




Size and urbanization increase autotrophy



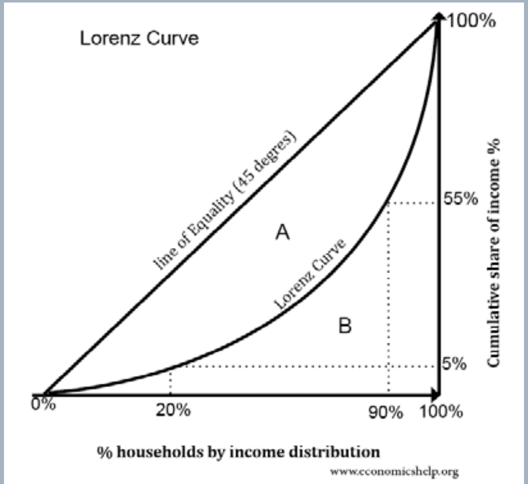
Bernhardt et al. 2018



2D Kernel density plots with GPP=ER line show:

- increasing autotrophy with urbanization (top panels, note different x-axis scales)
- Increasing metabolic variability primarily with watershed size (bottom panels, note same x-axis scale)

Inequality and flashiness

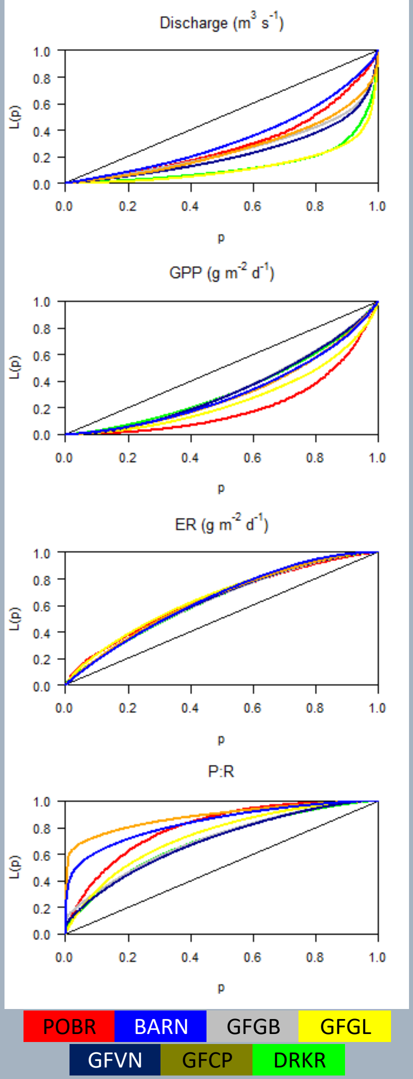


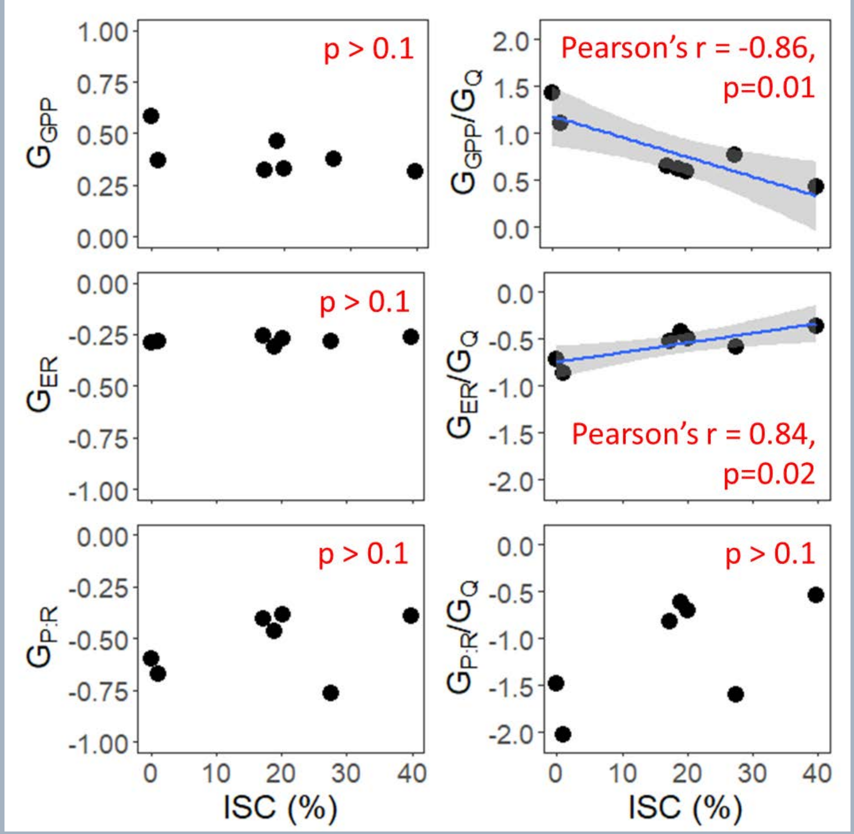
Expresses (in)equality, common in economics

Can be used to calculate Gini coefficient:

$$G = A/(A+B)$$

Inequality increases with G





G_q increased (more flashy) with ISC (not shown, $p<0.1$), but was not correlated with G_{GPP}, G_{ER}, or $G_{P:R}$

ISC did not describe variation in metabolism alone (left panels), but after accounting for hydrologic flashiness (right panels), ISC predicted metabolic regimes

Q&A – section 2

Moderator - Emma Rosi

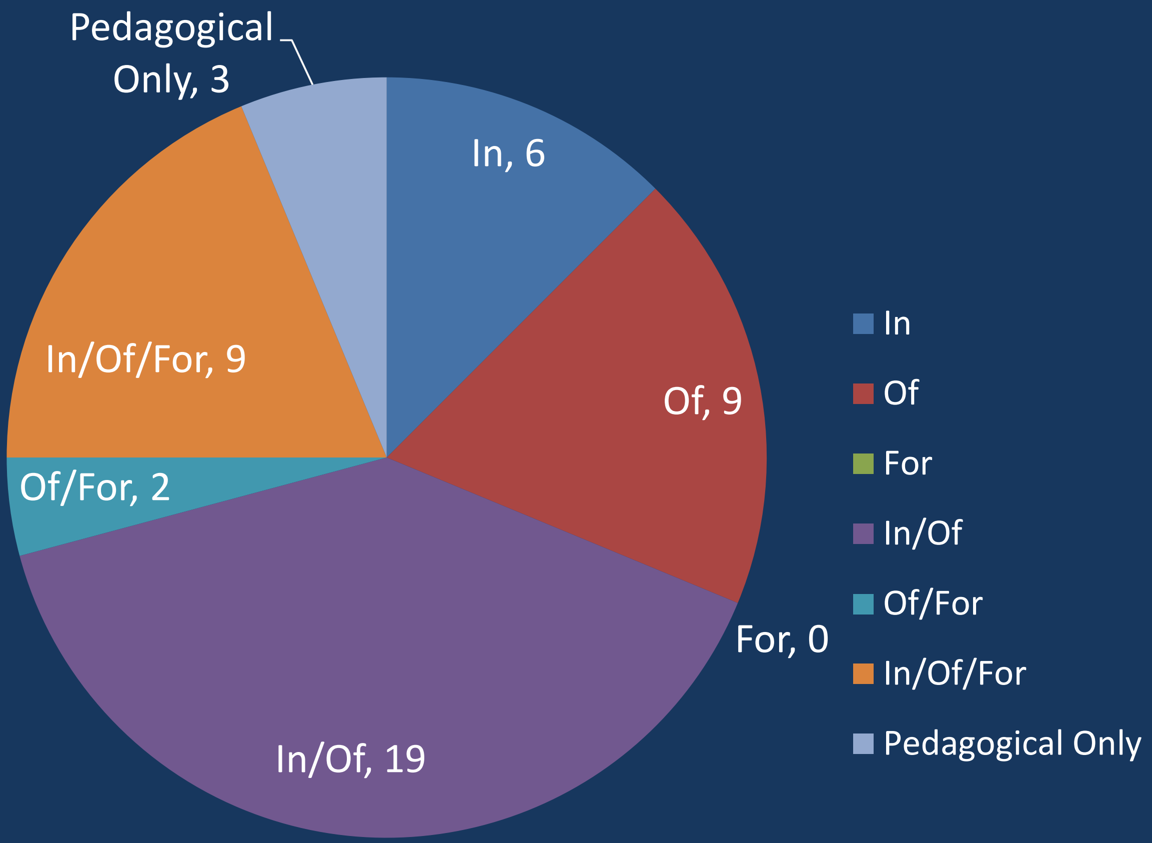
Teaching in and of the City. Progress towards a paper summarizing our teacher research.

Alan Berkowitz, Cary Institute

Summarizing our Teacher Research

- Chapter in BES book - Teaching and learning the Baltimore ecosystem
- Teaching In, Of and For the City

Categories	Descriptions	Examples
In	focuses teaching on land/water patches within the city, suburb or exurbs as an analog of non-urban habitats	Ex: Conducting a biodiversity study in the schoolyard, measuring transpiration on trees in the schoolyard, doing a stream study in an urban stream but without connections to improving stream health
Of	teaching recognizes that the urban setting is a social-ecological system that includes biological, social and built components; focus is not just on the biotic communities in the city but that of a holistic social-ecological system	Ex: acknowledging that people and urban structures are part of the urban ecosystem. Teaching specifically about Baltimore and phenomena that are found in Baltimore
For	includes knowledge generated by both ecology in and ecology of and acknowledges the advancement of social goals of urban sustainability, encouraging urban dwellers to shape a more sustainable urban future	Ex: Challenging students to think about, discuss or design ways to improve the environment in the City.

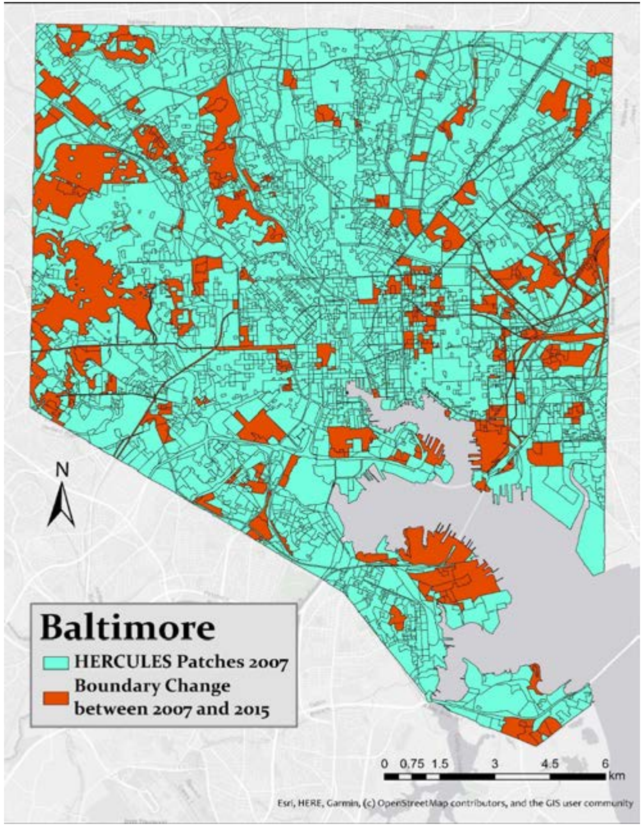

Pedagogical Only, 3
In, 6
Of, 9
For, 0
In/Of, 19
Of/For, 2
In/Of/For, 9
In
Of
For
In/Of
Of/For
In/Of/For
Pedagogical Only

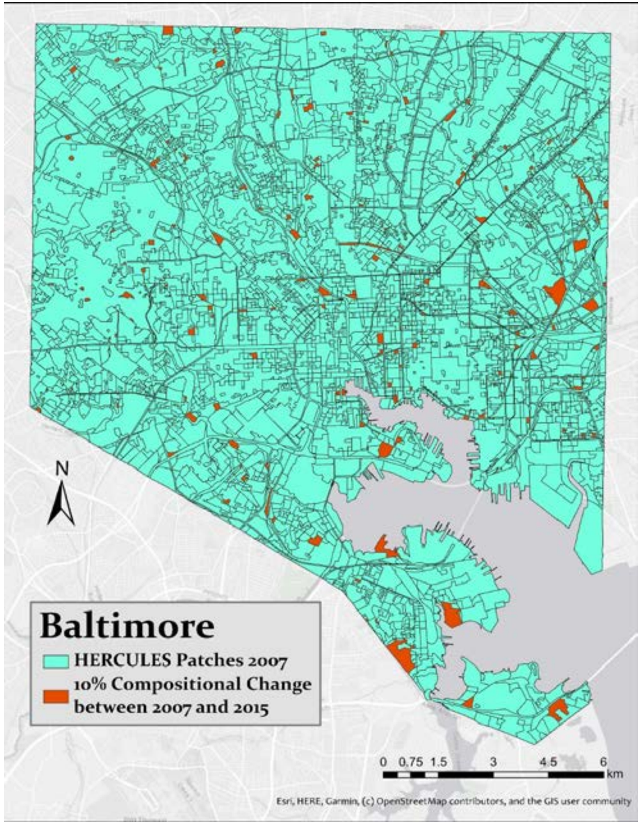
Using land cover signatures to track long-term change in Baltimore’s heterogeneity.

Mary Cadenasso, University of California, Davis

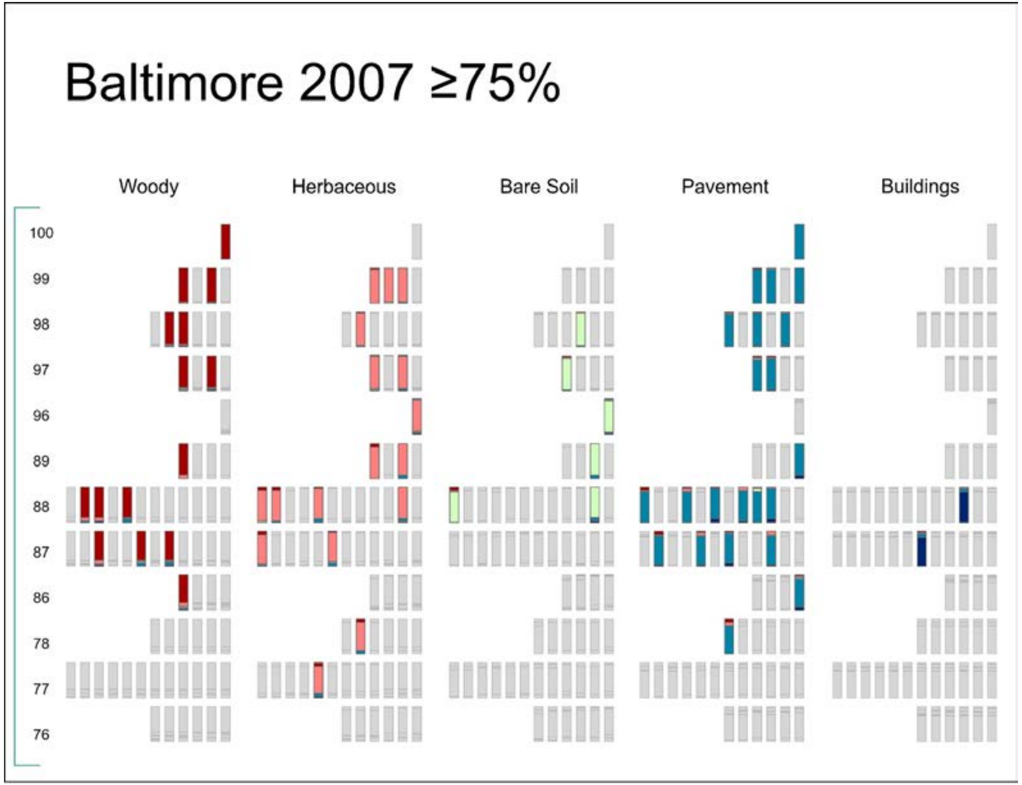
Using “signatures” to synthesize urban land cover change in Baltimore

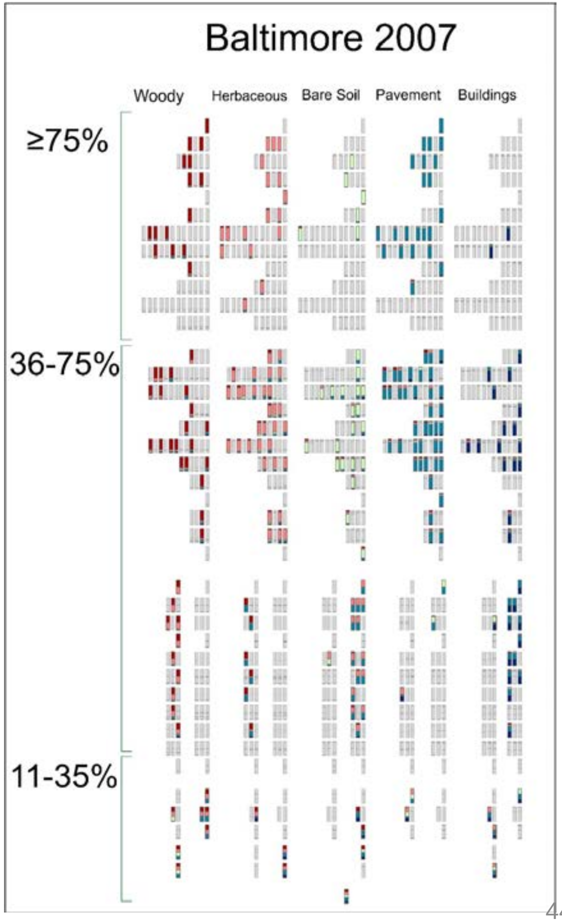
Mary L. Cadenasso | University of California, Davis



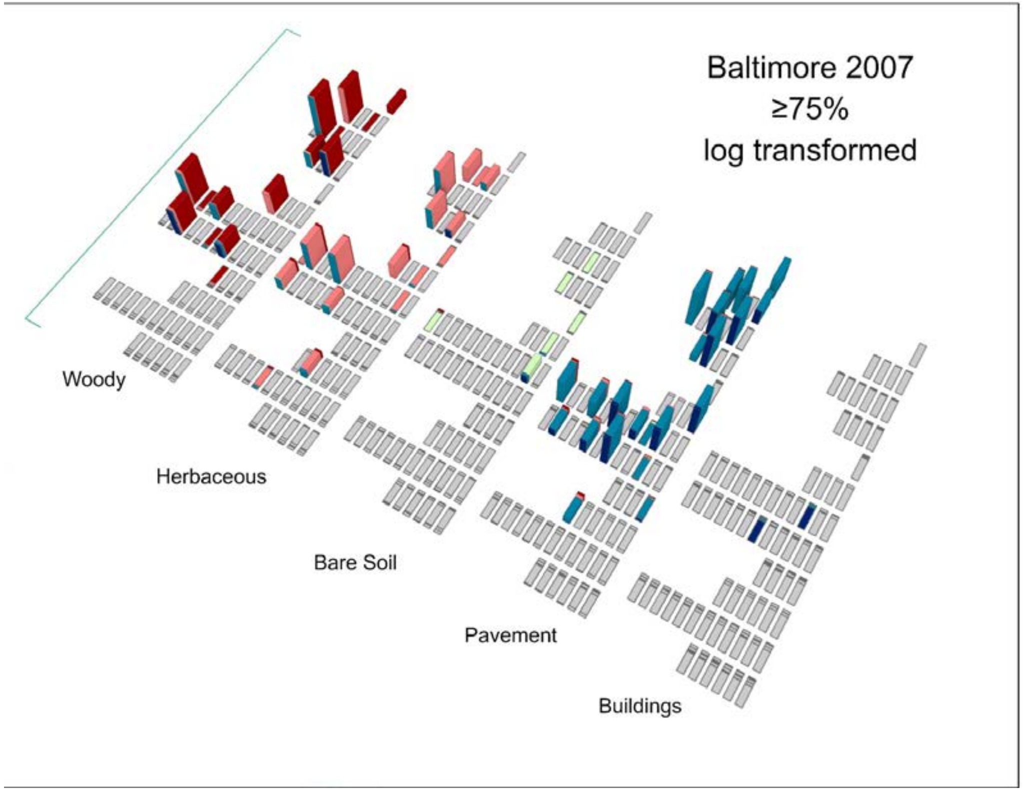


Land cover signature: patch types present out of all possible





Land cover signature: Actual frequency of present patch types



Why?

- Quantifying systems change.
    - Ecological significance of the change?
    - Is there a threshold of significance of change within or between suites?
    - Is there a predictable trajectory of change?
- Are cities more similar in land cover regardless of context or does context lead to different patterns and combinations?
- Are there consistent combinations of land cover? As land cover changes are some combinations more resistant to change than others?

Little leaks deliver large loads: Mass balance of pharmaceuticals in the Gwynns Falls watershed.

Megan Fork, Cary Institute

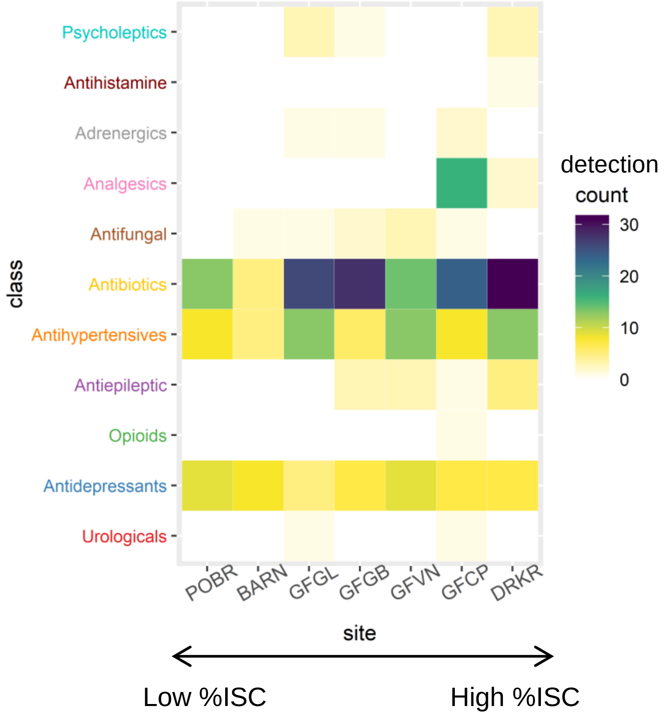
Little leaks deliver large loads:

Mass balance of pharmaceuticals in the Gwynns Falls watershed

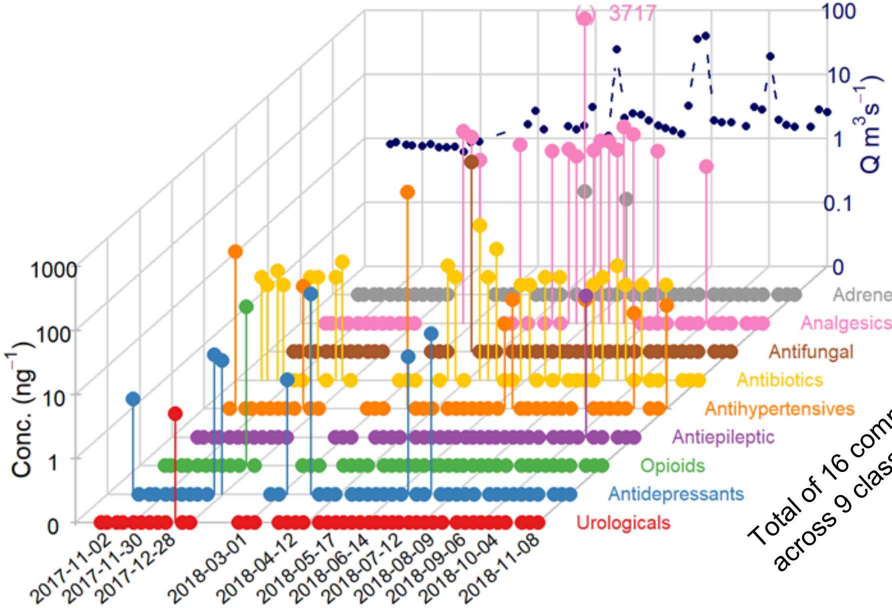
Megan L. Fork, Cary Institute of Ecosystem Studies

Weekly samples of BES streams screened for 92 pharmaceuticals:

Variability in space:



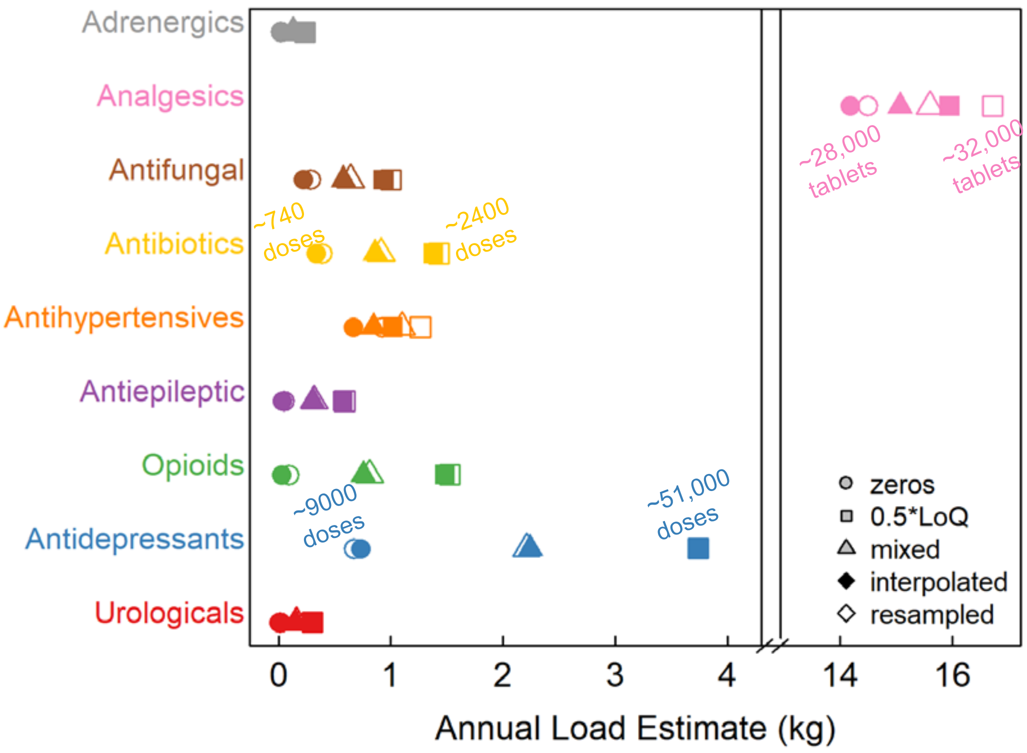
Variability over time:
(Carroll Park)



Total of 16 compounds detected across 9 classes

We calculated annual loads using a portfolio approach to control for:

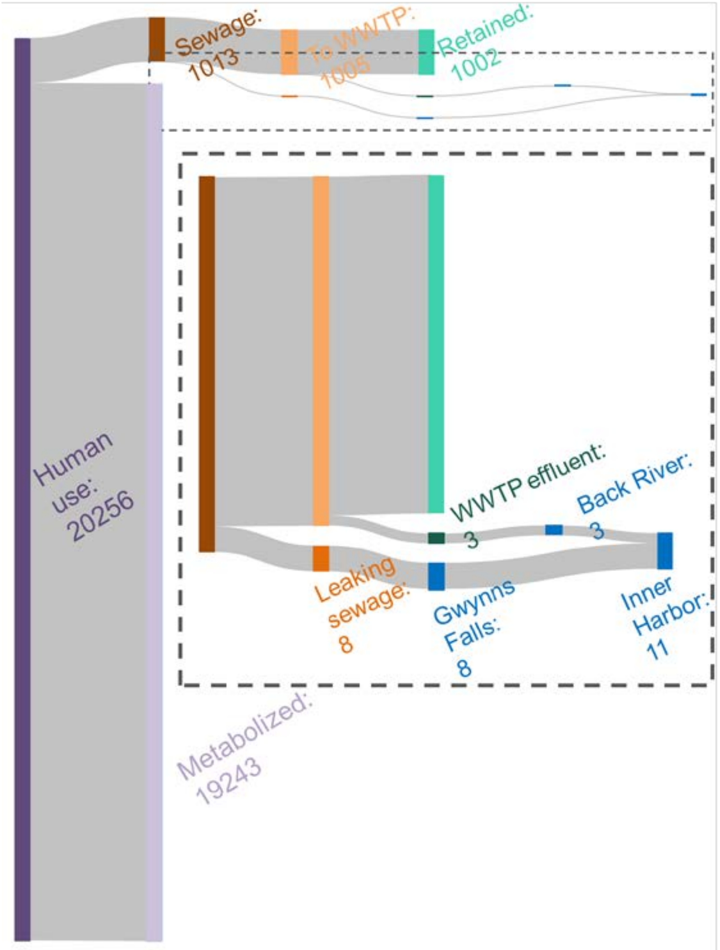
1) Several observations below the method level of quantification for individual compounds
   (shape: ● zeros, ■ 0.5*LoQ, ▲ half of each)
2) Unknown temporal autocorrelation between observations
   (filled: piecewise linear interpolation, open: random resampling from observed concentrations)



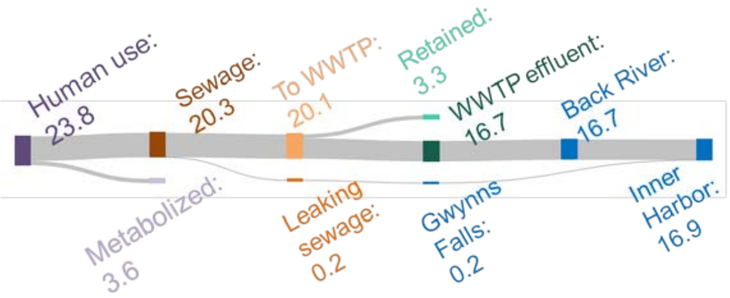
These annual loads are very similar to independent estimates based on literature concentrations in raw sewage and reported volumes of SSOs

Annual mass balance of pharmaceuticals in the Gwynns Falls watershed (kg):

Acetaminophen



Trimethoprim



- Sewage: mean reported concentrations of pharmaceuticals in WWTP influent*per capita sewage volumes*watershed population
- Human Use: back-calculated from sewage given % metabolized
- Leaking sewage: volume of reported SSOs* concentration in WWTP influent
- WWTP effluent: mean reported percentage of influent in effluent from WWTPs with similar residence time

Know your watershed and know your neighbor: paths to supporting urban watershed management in Baltimore and Phoenix.

Dexter Locke, USFS

Top-down (centralized) or bottom up (decentralized)?

A. Examine stated willingness to support taxes and/or volunteer to improve water quality by:

- Watershed knowledge
- Social ties
- When controlling for demographic differences

B. State-based solutions (tax money for pipes) vs voluntary solutions (alternative yard care, clean ups, rain barrels).

Locke, D. H., York, A., & Grove, J. M. (2020). Know your watershed and know your neighbor: Paths to supporting urban watershed conservation and restoration in Baltimore, MD and Phoenix, AZ. *Landscape and Urban Planning*, *195*(November 2019), 103714. https://doi.org/10.1016/j.landurbplan.2019.103714

treesearch.com

dexterlocke.com

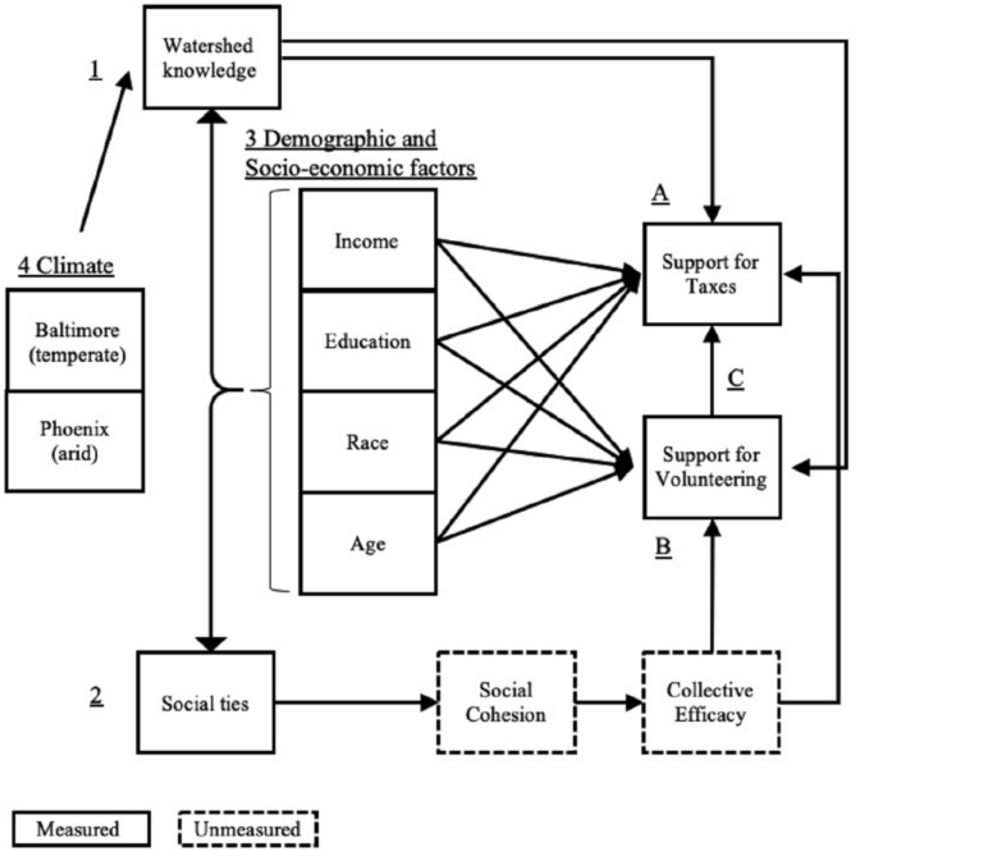


Fig. 1. Watershed knowledge and Collective Action Model for the Conservation and Restoration of Watersheds in the BES and CAP urban LTERs.

TAX

	Willingness to support tax (Baltimore)			Willingness to support tax (Phoenix)		
	Odds Ratio	95% CI	p	Odds Ratio	95% CI	p
(Intercept)	0.31	0.14 to 0.68	**.004**	1.98	0.98 to 4.03	.057
Do you live in a watershed? (ref = Yes)						
No	0.77	0.60 to 0.98	**.035**	0.76	0.53 to 1.10	.148
Don't Know	1.10	0.67 to 1.81	.718	1.18	0.68 to 2.07	.556
# of neighbors known by name	0.85	0.75 to 0.96	**.008**	0.88	0.78 to 0.99	**.037**
Income	1.13	1.04 to 1.22	**.003**	1.00	0.93 to 1.08	.967
Education	1.30	1.16 to 1.46	**<.001**	1.11	1.00 to 1.25	.060
Race (White)	0.98	0.69 to 1.38	.898	0.72	0.52 to 0.99	**.042**
Age	1.02	0.92 to 1.12	.752	0.90	0.82 to 0.99	**.032**
Observations	1193*			1237*		
Pseudo-R^2	R^2_{cs} = .395 R^2_N = .470 D = .046			R^2_{cs} = .334 R^2_N = .402 D = .018		
AIC	1612.941			1705.070		
$X^2_{deviance}$	p=.000			p=.002		

*Not all respondents answered questions, hence the lower N

Curriculum for BES science in the City. Update on Comp Hydro and Investigating Urban Ecosystems curricula.

Bess Caplan, Cary Institute

Integrating Chemistry and Earth Science (ICE)

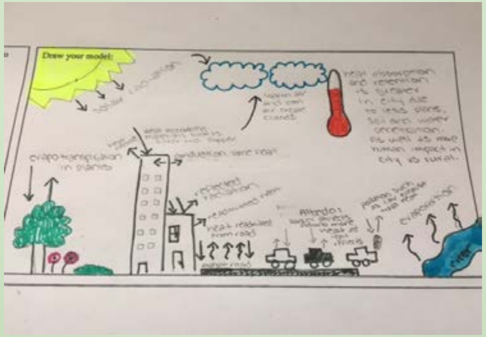
Description: Year 4 of ICE curriculum in Baltimore City High Schools (~60 teachers). ICE has ~15 development team teachers (DTT) to provide feedback, student artifacts and data on the curriculum.

Updates:

- Curriculum development.

Unit 4: Chemical Reactions

Unit 6: Thermochemistry



Unit 7: Baltimore's Mountains

- Monthly DTT meetings on research, collaboration and curriculum.
- In the last 3 months we have had weekly meetings on curriculum and distance learning platforms with Baltimore teachers.
- Haven't resolved the question of dissemination beyond Baltimore.

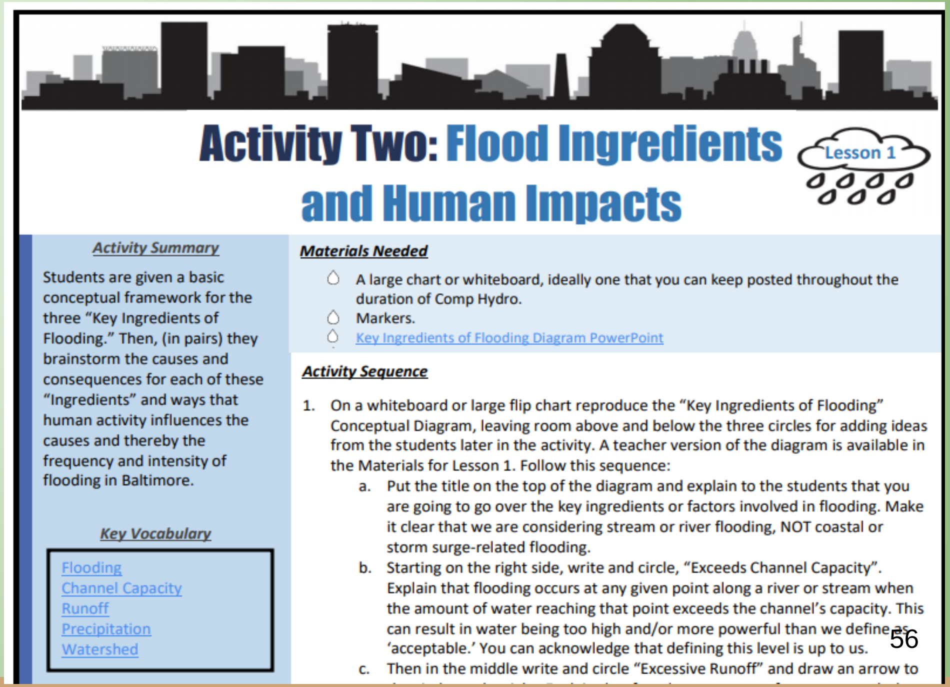
BALTIMORE CITY PUBLIC SCHOOLS

Computation and Visualization to Build Model-based Water Literacy

Description: The Comp Hydro curriculum closely examines precipitation and runoff using investigations and explorations of these two phenomena and how they have contributed to flooding in Baltimore.

Updates:

- Curriculum published online and broadly disseminated.
- Curriculum and training workshops.
- Feedback collected from teachers on applications in their classroom.
- Close to done for curriculum commitment.



Activity Two: Flood Ingredients and Human Impacts

Lesson 1

Activity Summary

Students are given a basic conceptual framework for the three "Key Ingredients of Flooding." Then, (in pairs) they brainstorm the causes and consequences for each of these "Ingredients" and ways that human activity influences the causes and thereby the frequency and intensity of flooding in Baltimore.

Key Vocabulary

Flooding
Channel Capacity
Runoff
Precipitation
Watershed

Materials Needed

- A large chart or whiteboard, ideally one that you can keep posted throughout the duration of Comp Hydro.
- Markers.
- Key Ingredients of Flooding Diagram PowerPoint

Activity Sequence

1. On a whiteboard or large flip chart reproduce the "Key Ingredients of Flooding" Conceptual Diagram, leaving room above and below the three circles for adding ideas from the students later in the activity. A teacher version of the diagram is available in the Materials for Lesson 1. Follow this sequence:
   a. Put the title on the top of the diagram and explain to the students that you are going to go over the key ingredients or factors involved in flooding. Make it clear that we are considering stream or river flooding, NOT coastal or storm surge-related flooding.
   b. Starting on the right side, write and circle, "Exceeds Channel Capacity". Explain that flooding occurs at any given point along a river or stream when the amount of water reaching that point exceeds the channel's capacity. This can result in water being too high and/or more powerful than we define as 'acceptable.' You can acknowledge that defining this level is up to us.
   c. Then in the middle write and circle "Excessive Runoff" and draw an arrow to

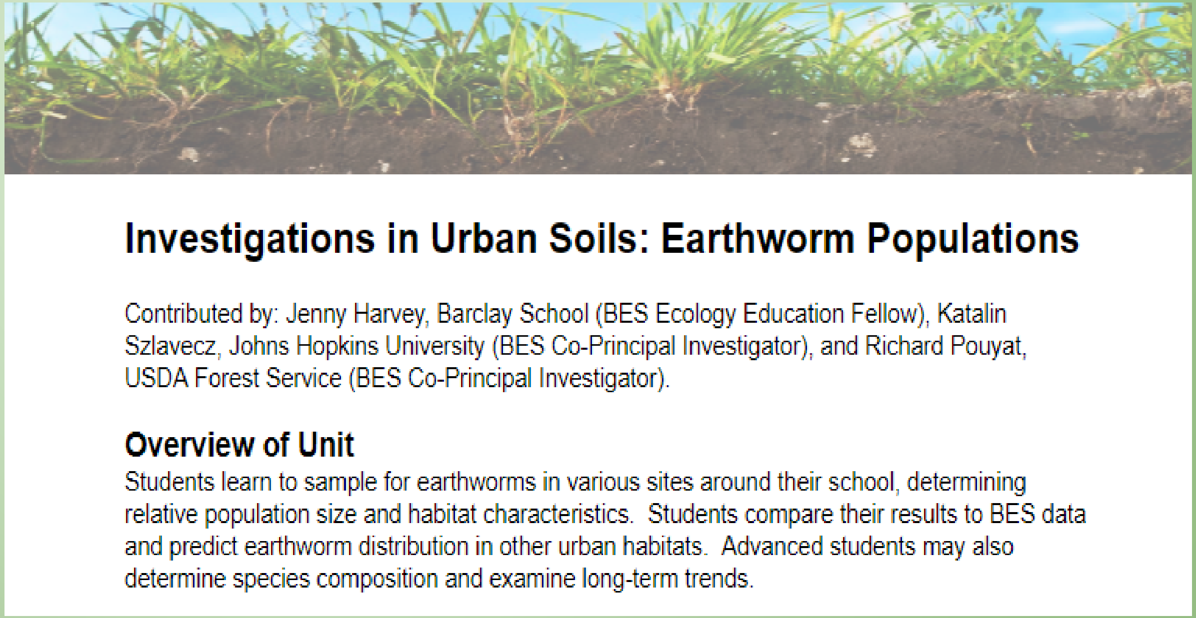
Investigating Urban Ecosystems Curricula

Description: Making progress on bringing older modules up to date.

Topics: Urban soils (Earthworms), Mosquito module, Water module and Tree module.

Updates:

- Protocols
- Template and visuals
- Worksheets
- Data
- NGSS connections
- Materials
- Resources



Investigations in Urban Soils: Earthworm Populations

Contributed by: Jenny Harvey, Barclay School (BES Ecology Education Fellow), Katalin Szlavecz, Johns Hopkins University (BES Co-Principal Investigator), and Richard Pouyat, USDA Forest Service (BES Co-Principal Investigator).

Overview of Unit

Students learn to sample for earthworms in various sites around their school, determining relative population size and habitat characteristics. Students compare their results to BES data and predict earthworm distribution in other urban habitats. Advanced students may also determine species composition and examine long-term trends.

Q&A – section 3

Moderator - Emma Rosi

Final remarks

Emma Rosi, Cary Institute

Questions? Comments? Email besinfo@caryinstitute.org

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Thank you!