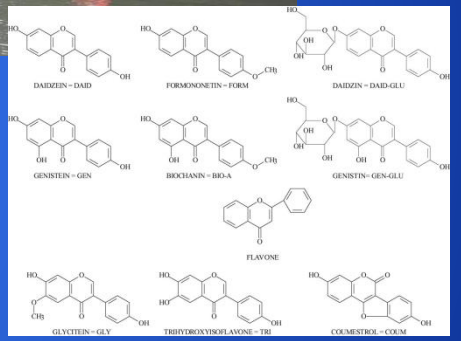
Endocrine Disrupting Compounds in the Chesapeake Bay Watershed – Where are We Going? Where Should We Go?



Patrick Phillips[1], *Dana Kolpin*[1], *Kelly Smalling*[1], *Vicki Blazer*[1], *Luke Iwanowicz*[1], *Megan Schall*[5], *Ryan Braham*[1], *Cassandra Ladino*[1], *Tia Scott*[1], *Michael Meyer*[1], *and Edward Furlong*[1]

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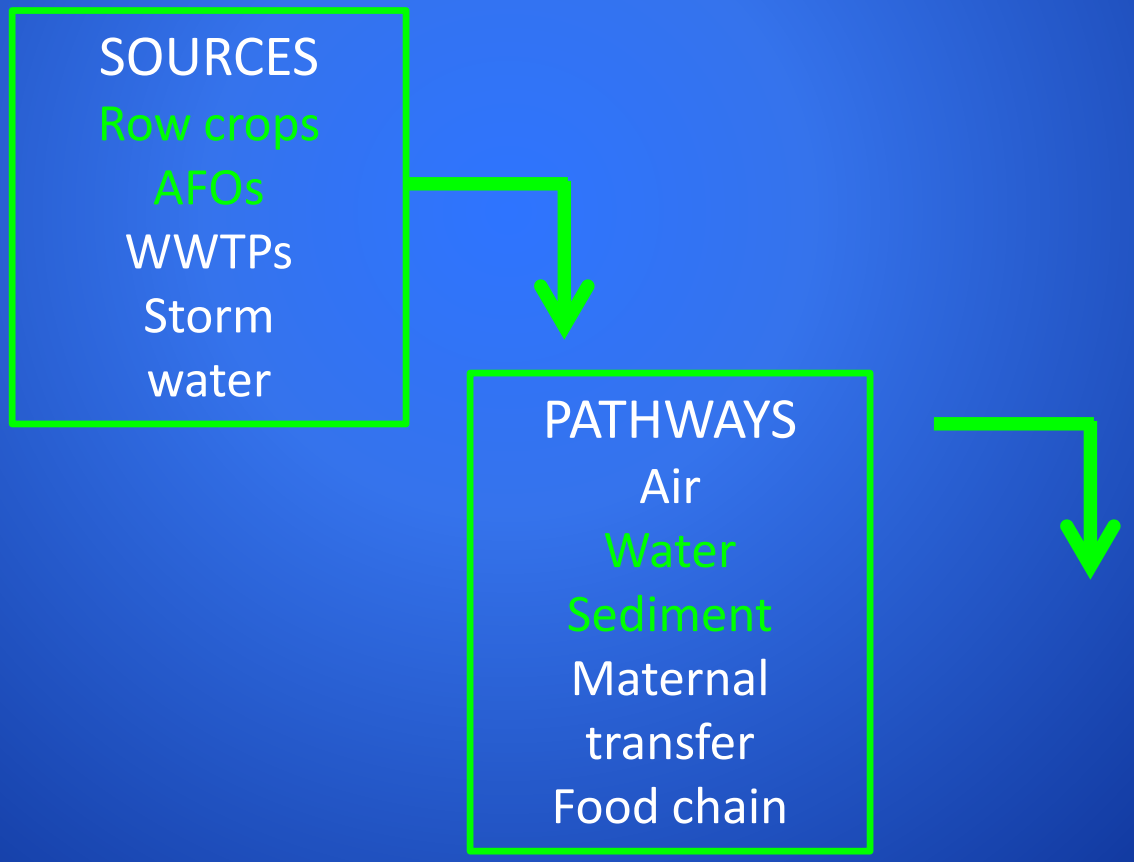
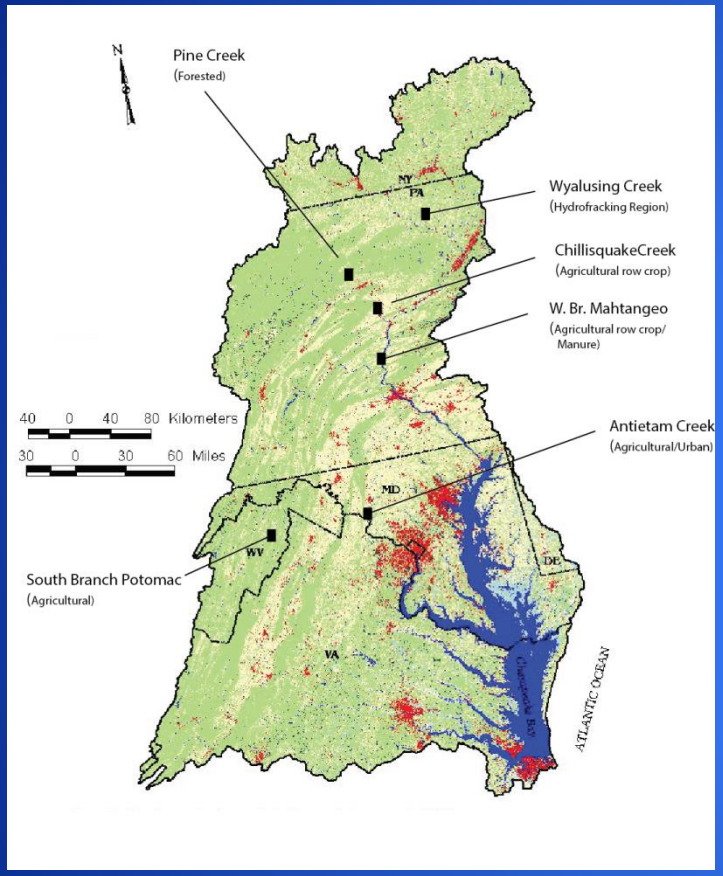
SOURCES + PATHWAYS

Sources, transport, distribution of EDCs



Chemical Analytes

- Estrogenicity and >200 Chemicals in Water
- Current Use Pesticides
- Hormones
- Phytoestrogens
- Plant/Animal Biochemicals
- Wastewater Compounds
- Pharmaceuticals
- Other Compounds



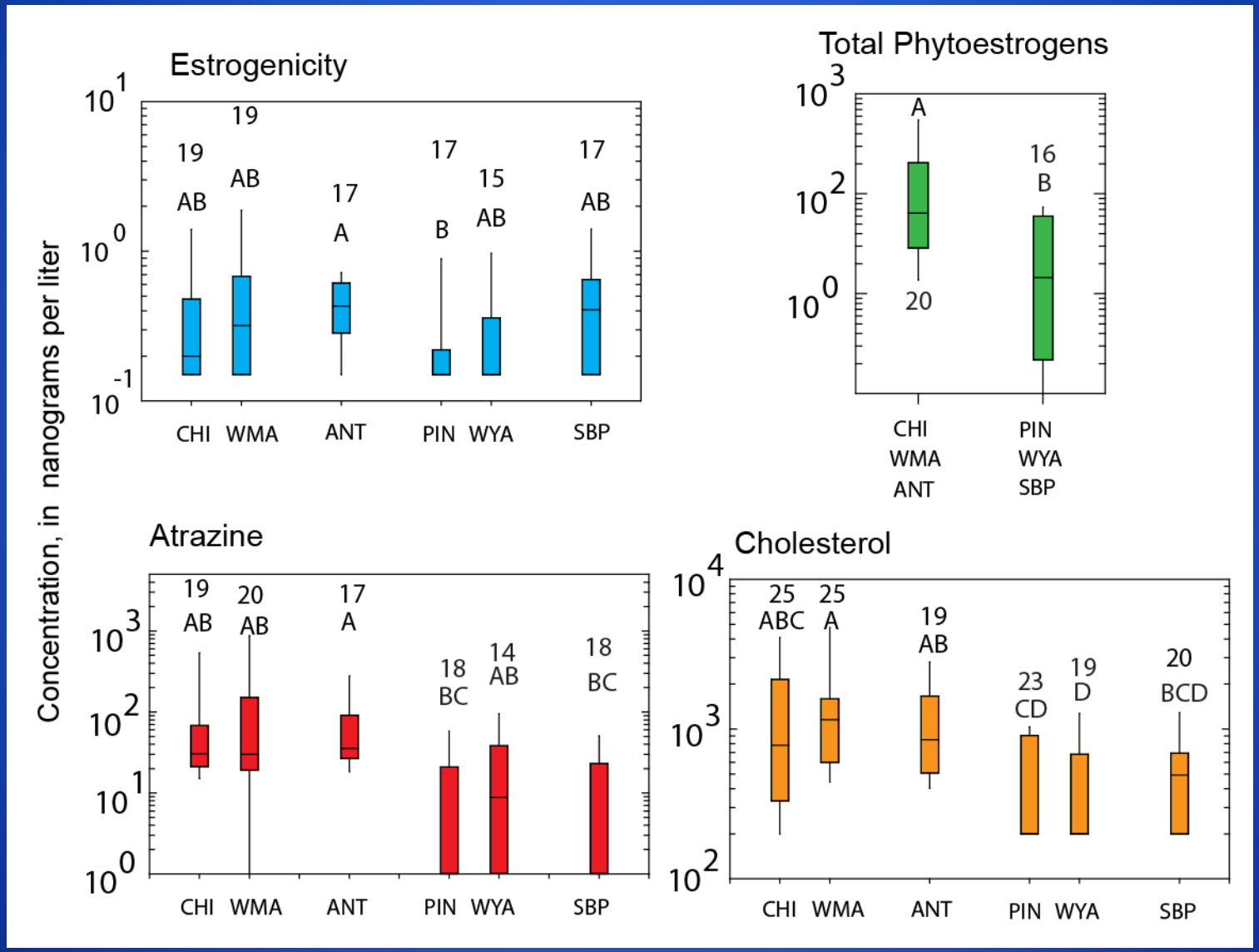
Network Design

- Six Sites, mostly agricultural
- Sampled November 2014-September 2016
- Targeted Storms

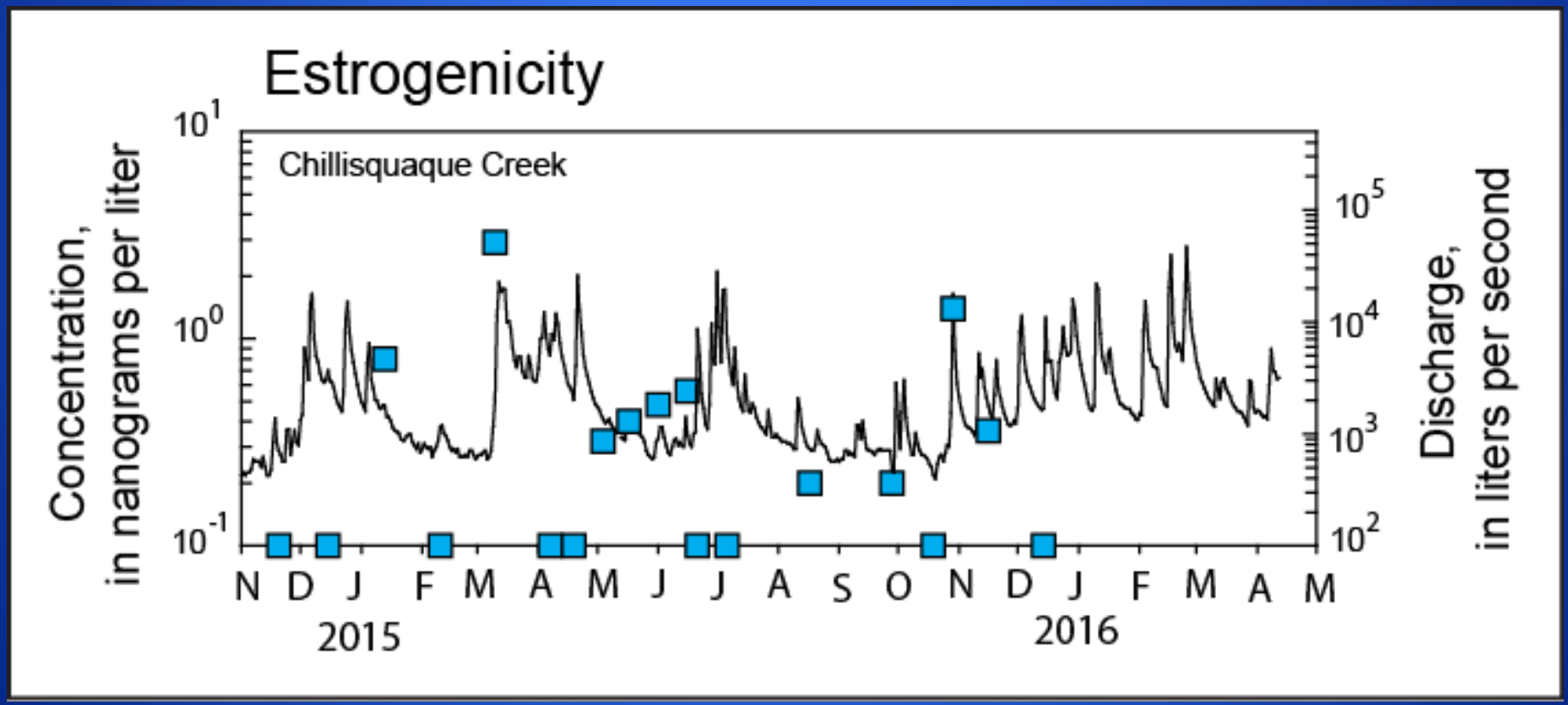
Questions

- What chemicals are present? Do they vary with land use?
- Do they contribute to measured Estrogenicity?
- How do concentrations vary with seasonality, flow, and other factors?
- Can we attribute these concentrations to sources ?
- What lessons do we have for managing this issue?

Concentrations by Site



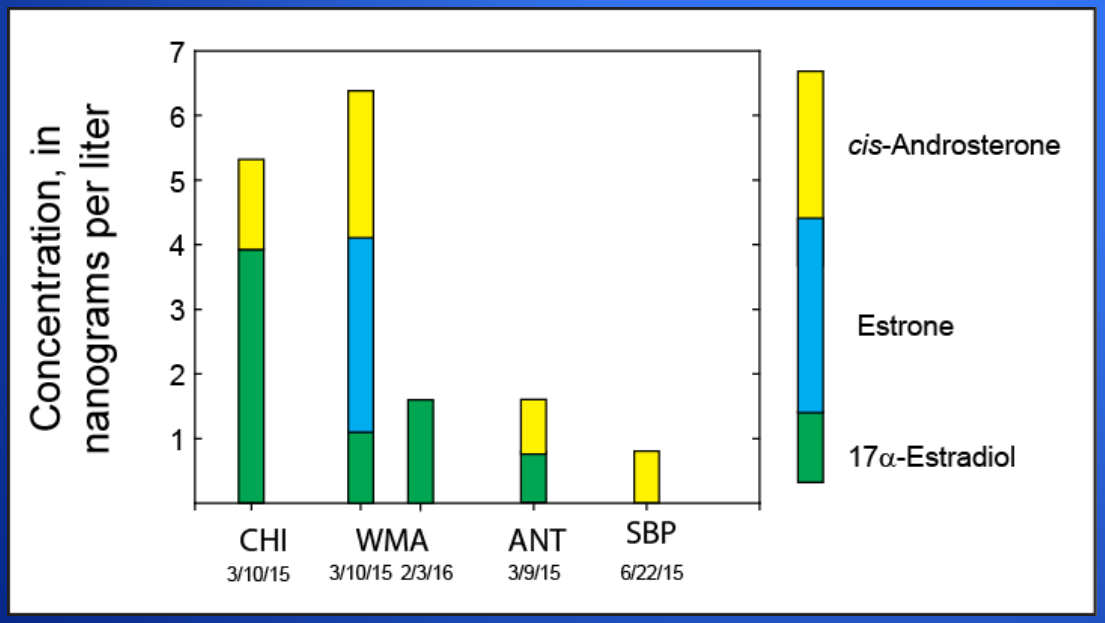
Estrogenicity Peaks During Stormflows



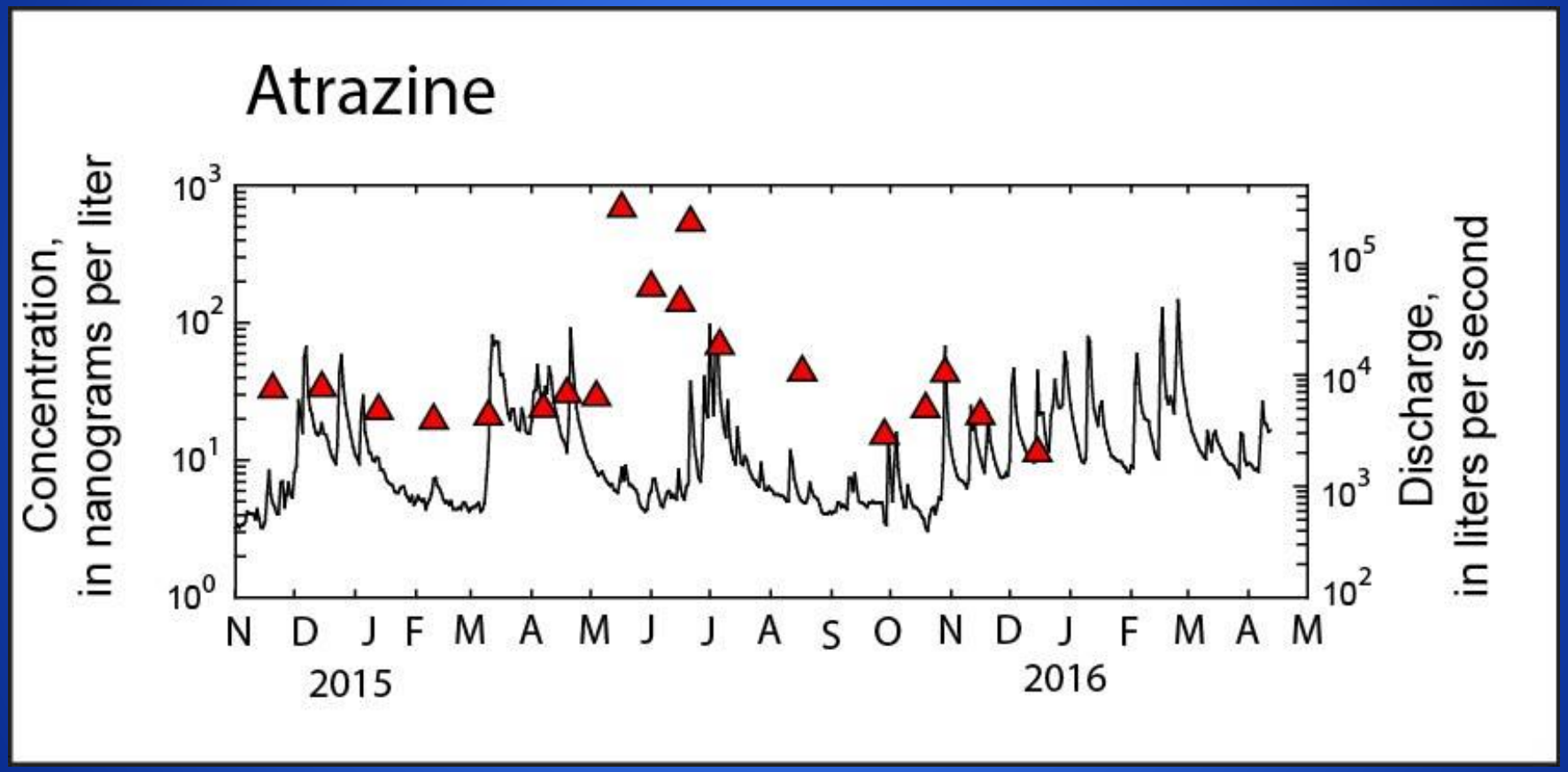
Are Hormones Important?

Hormones Detected in <5% of Samples

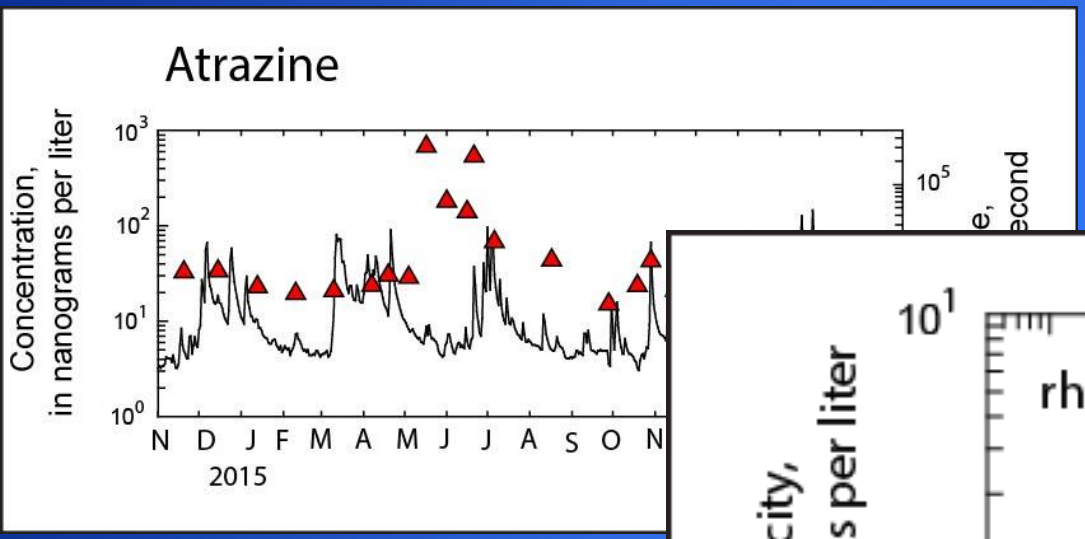
Hormones only Detected During Stormflows

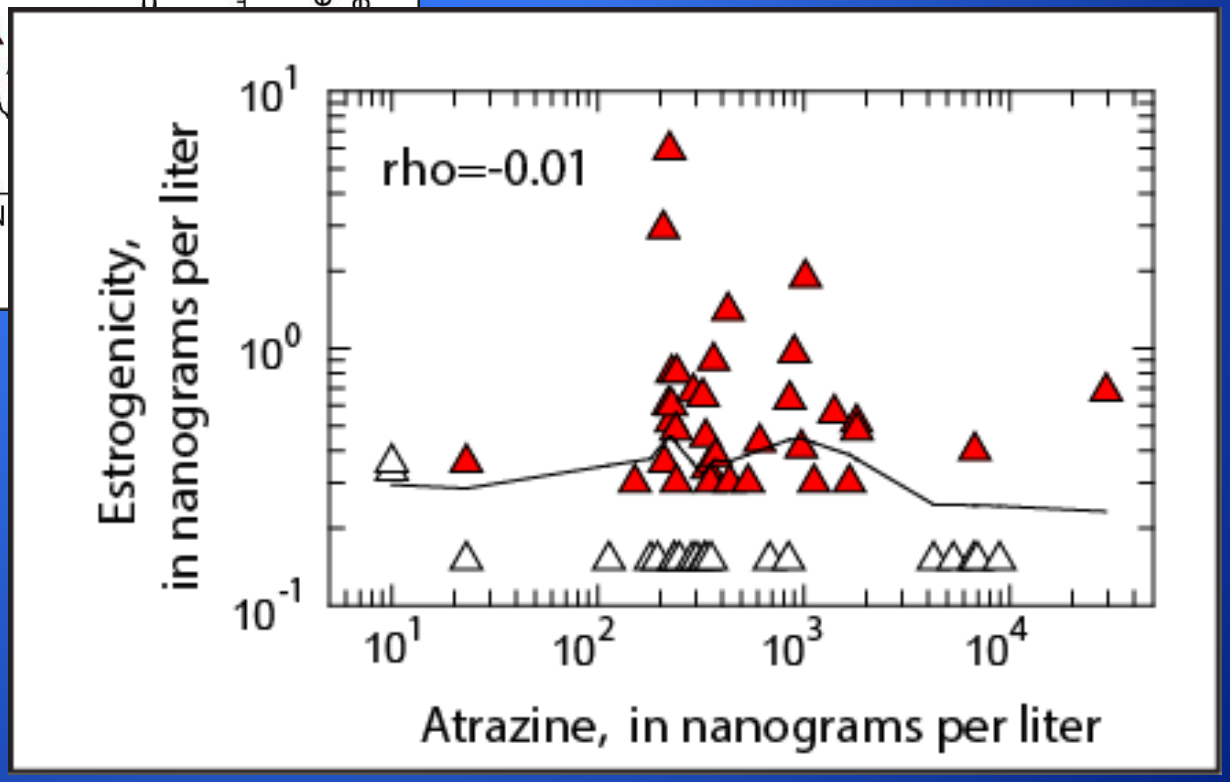


Is Atrazine Important?



Atrazine *is not* Correlated with Estrogenicity





Phytoestrogens Present in Plant Residues, Manure, Wastewater

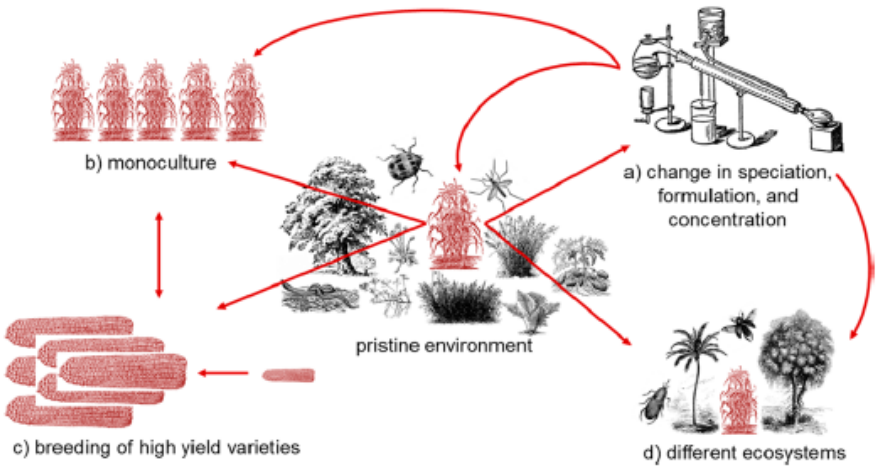


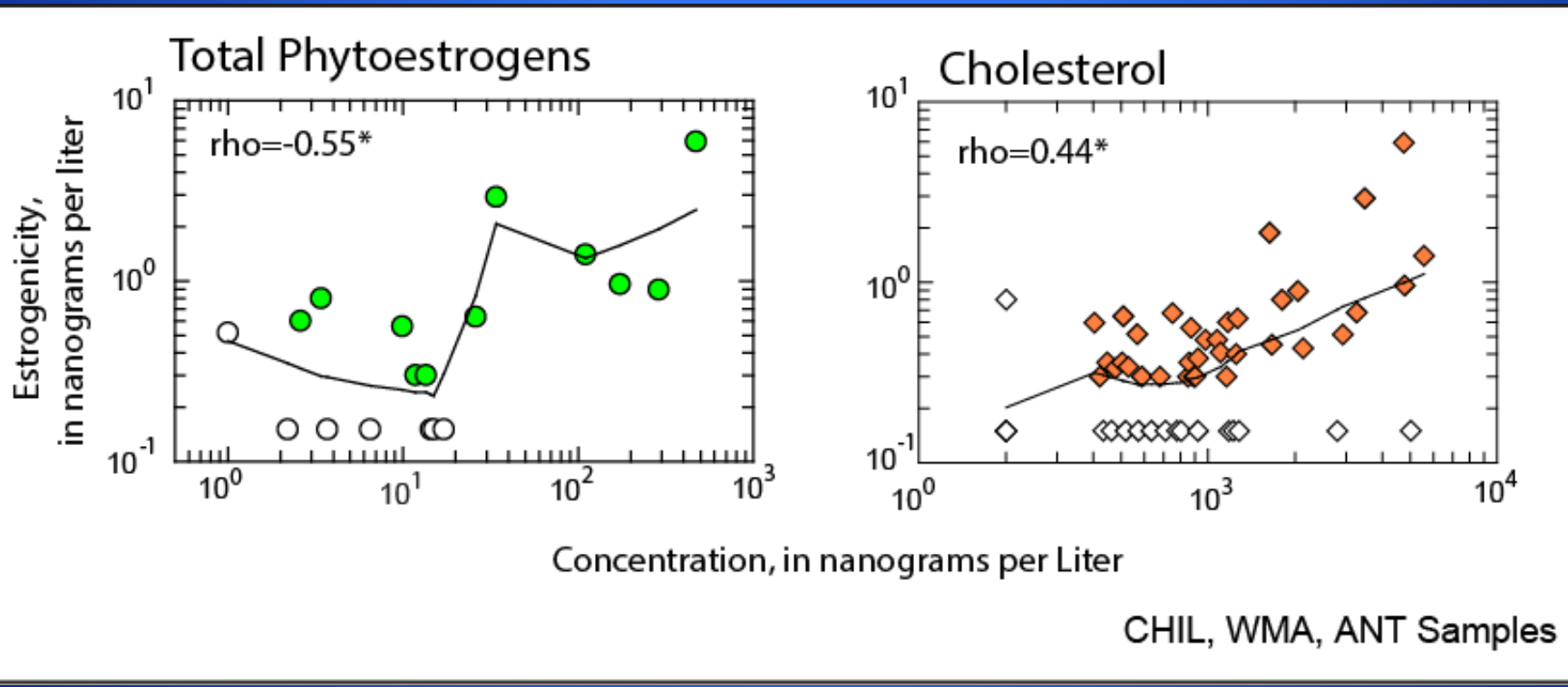
Figure 1. Potentially orders-of-magnitude higher phytotoxin exposures in anthropogenically managed/affected (agro-)ecosystems than in the pristine environment, for example, due to (a) biopesticide production and application, (b) monocultures of phytotoxin-containing crops, (c) breeding of high yield phytotoxin-containing crops, and (d) introduction or invasion of phytotoxin-containing plants into different habitats. All drawings (here and in abstract art figure) from ETC

In Swiss Rivers, grasslands contribute the majority of Phytoestrogens

(Hoerger and others, 2011, Environ. Sci. Technol. 2011, 45, 6752–6760)

Figure from Bucheli, 2014 ES&T, 2014, 48, 13027-13033

Cholesterol/Phytoestrogens *are* correlated with Estrogenicity



Higher Flow=More Complex Phytoestrogen Mixture

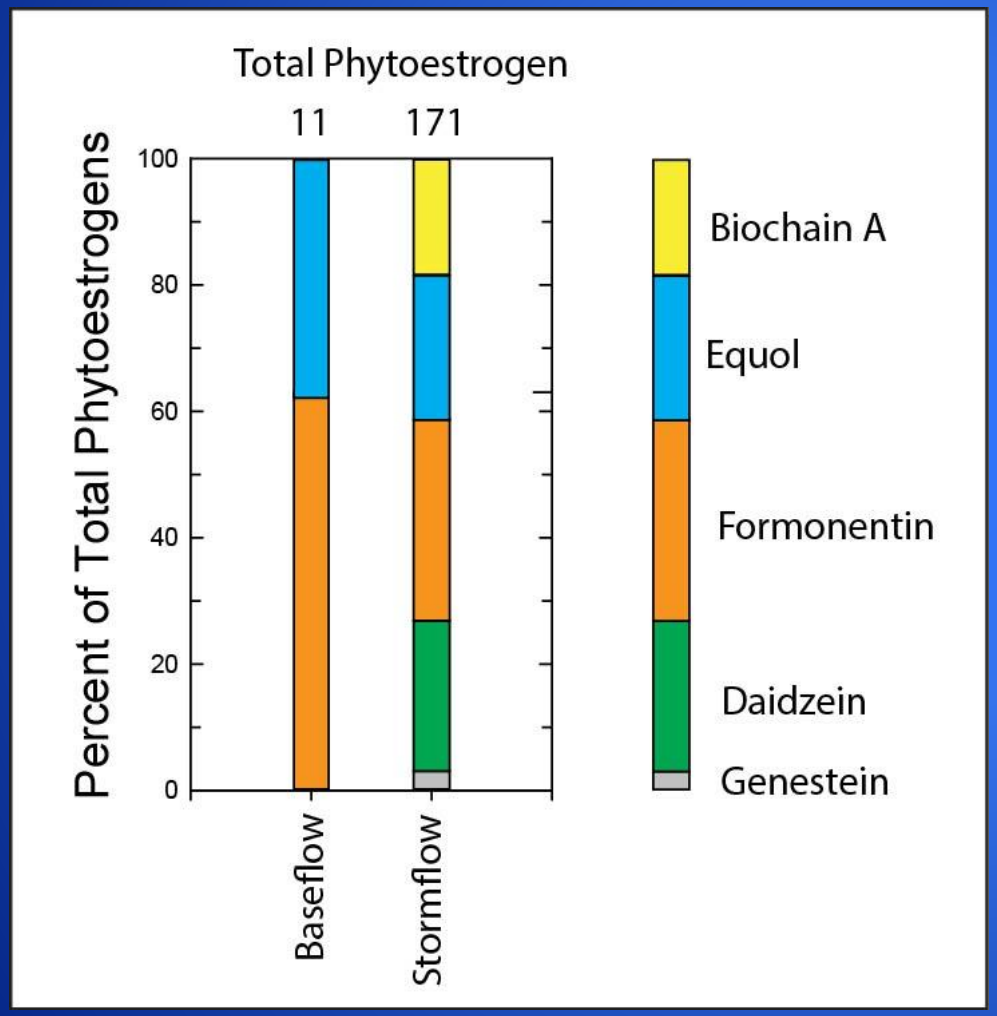
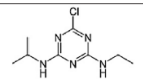
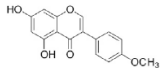
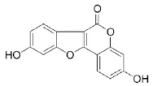
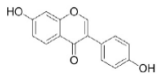
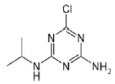
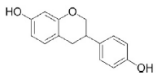
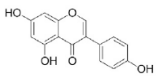
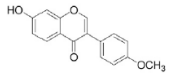
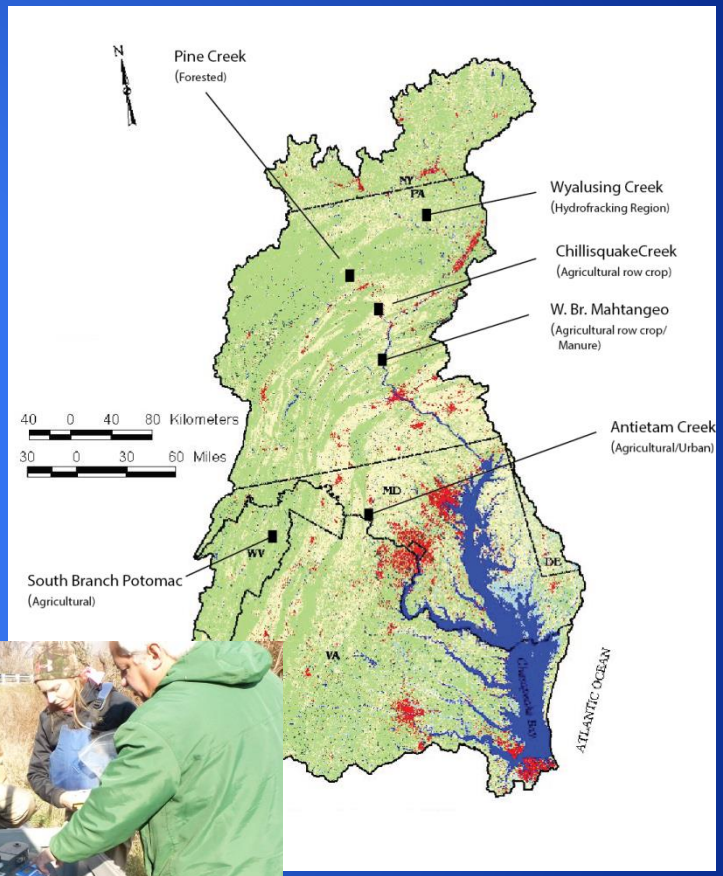


Table 2. Targeted phytoestrogens, mycotoxins, and herbicide compounds investigated for this study.

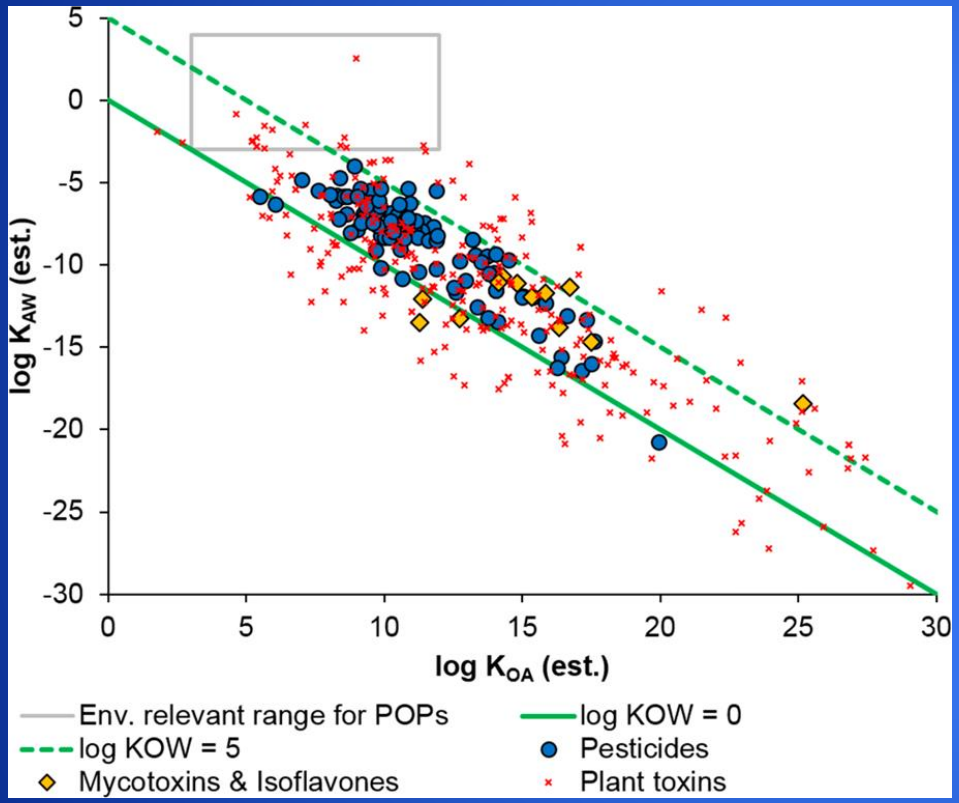
Compound	CAS number	Molecular structure	Molecular formula	Log K_{ow}	Origin
Atrazine (ATZ) 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine	1912–24–9		$C_8H_{14}ClN_5$	2.6†	herbicide
Biochanin A (BIO) 5,7-dihydroxy-3-(4-methoxyphenyl)chromen-4-one	491–80–5		$C_{16}H_{12}O_5$	3.4‡	isoflavone (e.g. red clover)
Coumestrol (COU) 3,9-dihydroxy-6-benzofurano[3,2-c]chromenone	479–13–0		$C_{15}H_8O_5$	1.6‡	coumestan (e.g. alfalfa, soybean, spinach)
Daidzein (DAI) 7-hydroxy-3-(4-hydroxyphenyl) chromen-4-one	486–66–8		$C_{15}H_{10}O_4$	2.6‡, 2.5§	isoflavone (e.g. soybean)
Deethylatrazine (DEA) 2-amino-4-chloro-6-(isopropylamino)-*s*-triazine	6190–65–4		$C_6H_{10}ClN_5$	2.5†	Atrazine degradate
Equol (3*S*)-3-(4-hydroxyphenyl)-7-chromanol	94105–909–5		$C_{15}H_{14}O_3$	3.7‡, 3.2§	isoflavone (metabolite of digestion process)
Genistein (GEN) 5,7-dihydroxy-3-(4-hydroxyphenyl) chromen-4-on	446–72–0		$C_{15}H_{10}O_5$	2.8‡, 3.0§	isoflavone (e.g. soybean)
Formononetin (FOR) 7-hydroxy-3-(4-methoxyphenyl) chromen-4-one	485–72–3		$C_{16}H_{12}O_4$	3.1‡	isoflavone (e.g. red clover)

What Do We Know

- Concentrations of many contaminants are highest in Chil, WMA, and ANT sites
- Hormones not frequently detected in water
- Phytoestrogen may be very important
- Storms are important

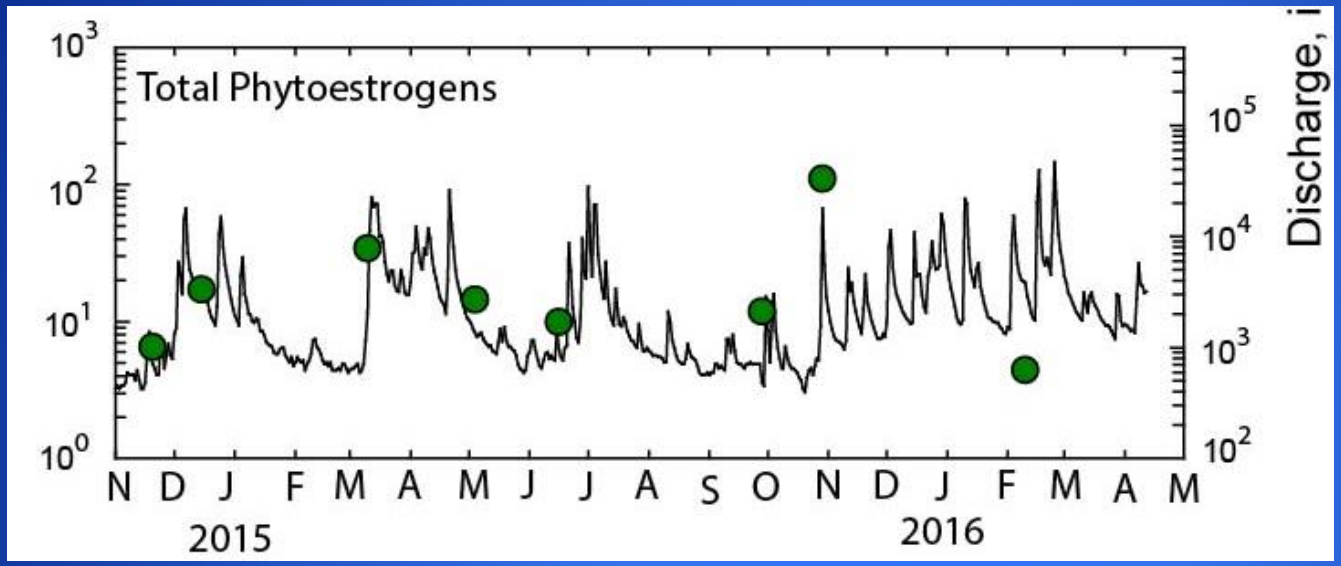


What we need to know



- Link with Fish Health (Vicki's talk)
- What aren't we measuring? (Jennifer's talk)
- Link to Larger Landscape (Yan's talk)
- Link between data and management of EDC s

Next Steps



- Fill in Data Gaps in 2015, get data for February 2016 Storm
- Interpret Bed Sediment Data
- Relate Data to Land Use
- Summarize findings in Journal Article
- Consider other Plant/Animal EDCs

Thanks to Field Crews!

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