

Endocrine Disrupting Chemicals Found in Agricultural Settings in the Chesapeake Bay Watershed

Kelly Smalling, Vicki Blazer, Patrick Phillips, Dana Kolpin, Luke Iwanowicz,
Stephanie Gordon and Daniel Jones (USGS)

Catherine McClure and Tyler Wagner (Penn State)

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Concept for Determining Highest Priorities for Research to Increase Understanding Impacts and Mitigation Options for Toxic Contaminants (Color codes are examples)

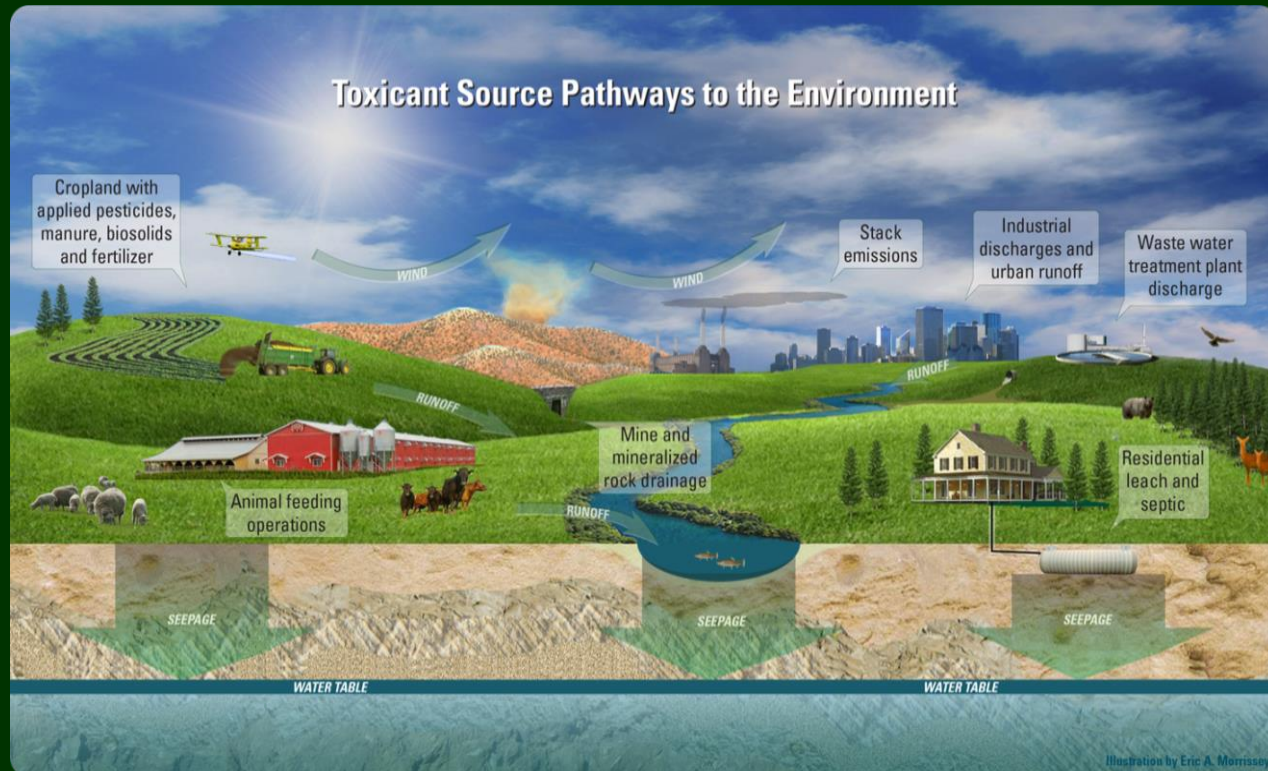
Contaminant Groups	Occurrence	Concentrations	Sources	Effects	Uncertainty
PCBs	Small	Mid	Mid	Small	
Dioxins/Furans	Small	Mid	Small	Small	
PAHs	Small	Small	Small	Small	
Petroleum Hydrocarbons	Mid	Mid	Small	Small	
Pesticides	Large	Large	Mid	Mid	Priorities for an agenda to increase certainty?
Bio. Hormones	Large	Large	Mid	Large	
Pharms.	Large	Large	Mid	Large	
HPCP	Large	Large	Mid	Large	
PBDEs	Large	Large	Mid	Mid	
Metals	Mid	Mid	Mid	Small	
Mixtures	Large	Large	Large	Large	

Toxic Contaminants Goal: Ensure that the Bay and its rivers are free of effects of toxic contaminants on living resources and human health.

Research Outcome: Increase our understanding of the impacts and mitigation options for toxic contaminants. Develop a research agenda and further characterize the occurrence, concentrations, sources and effects of mercury, PCBs and other *contaminants of emerging and widespread concern*. In addition, identify which BMPs might provide multiple benefits of reducing nutrient and sediment pollution as well as toxic contaminants in waterways.



- ✓ Document the sources, occurrence and transport of chemicals associated with agricultural settings
- ✓ Provide the science to help mitigate contaminants emphasizing co-benefits with nutrient/sediment reductions

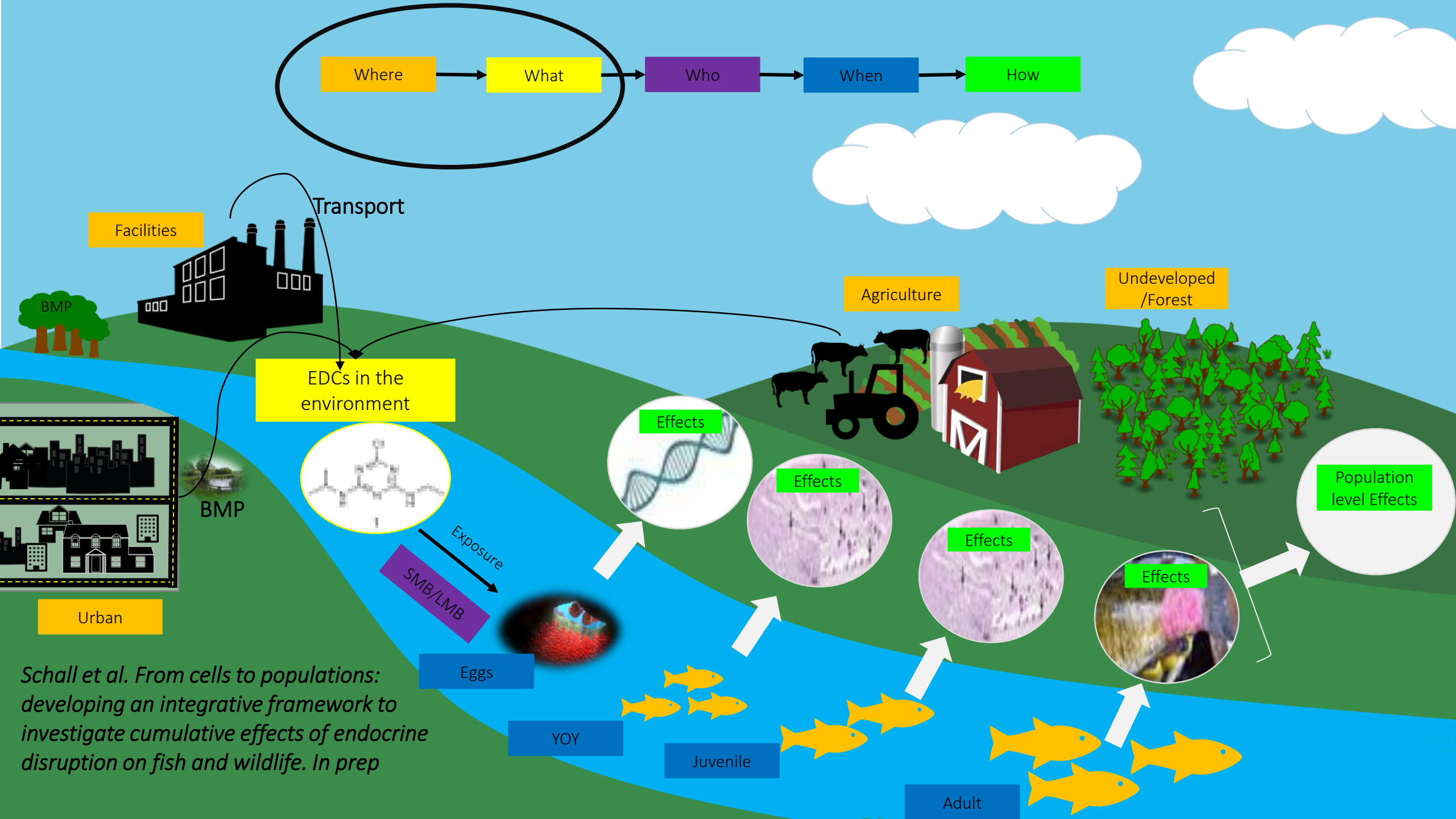


- Geospatial analysis of sources
- Chemical exposure
- Monitoring of environmental variables - flow
- Spatial and temporal variations
- Co-occurrence modeling
- Management implications?

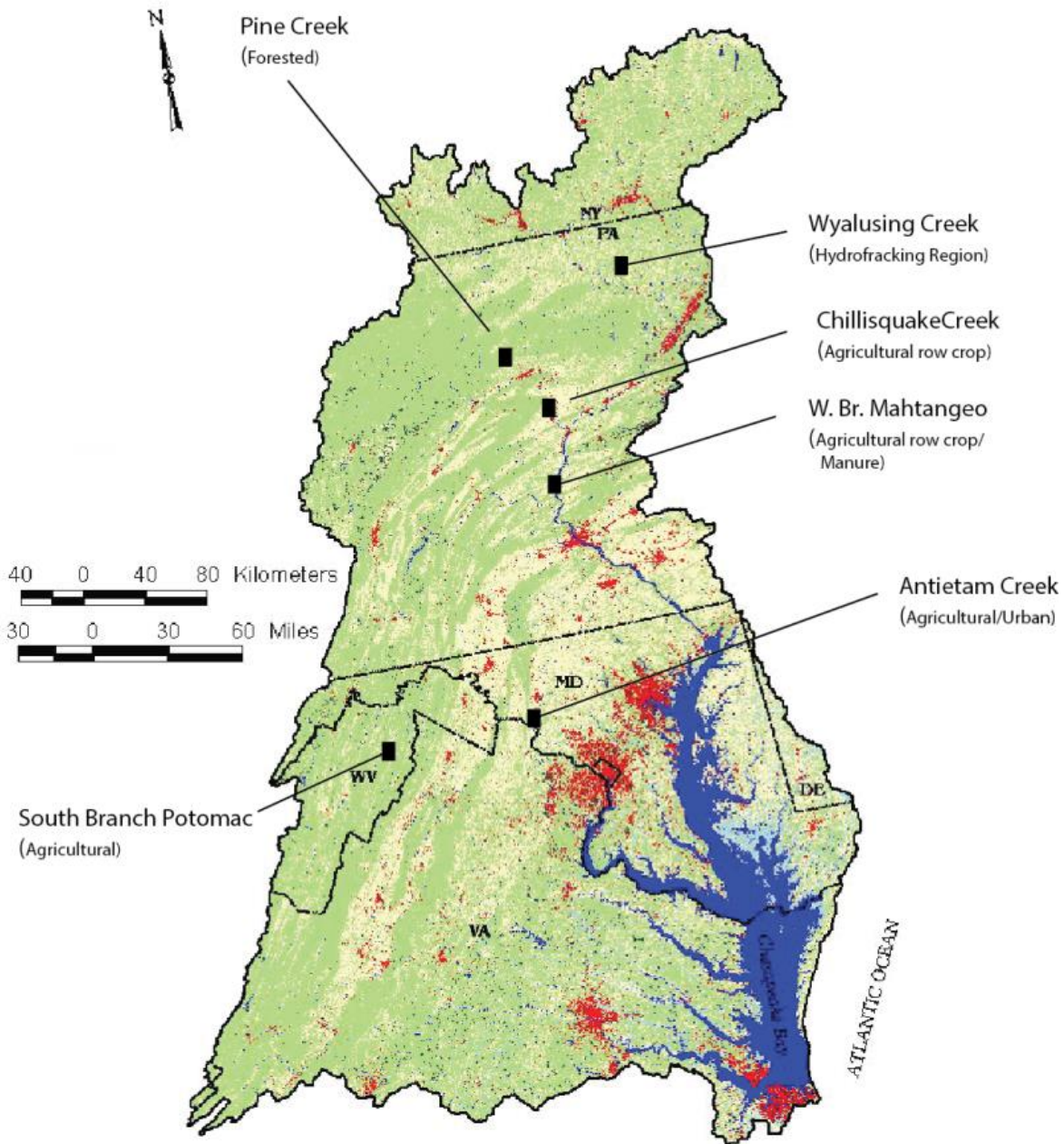
Examples of EDCs

- ✓ Pharmaceuticals (human or veterinary)
- ✓ Naturally occurring estrogenic compounds
- ✓ Pesticides
- ✓ Plasticizers
- ✓ Flame retardants
- ✓ POPs (PCBs, dioxins/furans)





Schall et al. From cells to populations: developing an integrative framework to investigate cumulative effects of endocrine disruption on fish and wildlife. In prep



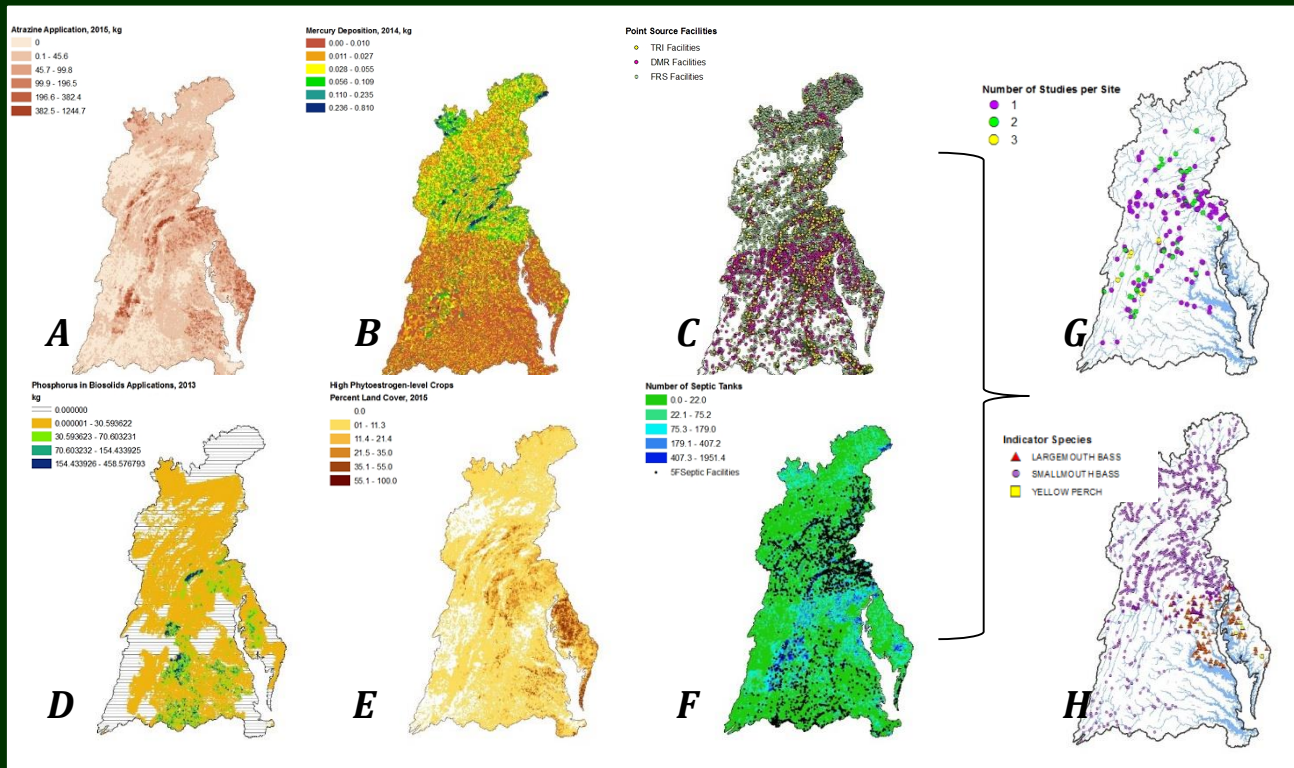
- ✓ Focused field studies in agricultural watersheds 2013-2017 with emphasis on chemistry, landscape information and fish health
- ✓ 4-6 sites sampled monthly Jan-March and July-Nov and bimonthly April-June from 2014-2017
- ✓ Water samples analyzed for pesticides, hormones, pharmaceuticals (human and veterinary), phytoestrogens, ect.

Sources, transport and occurrence

- Are there observed relationships between key compounds and flow across sites and seasons?
- Are there certain land-use predictors for key compounds or those that co-occur?
- Management relevance - can WQ management actions help minimize EDCs?



Geospatial source characterization

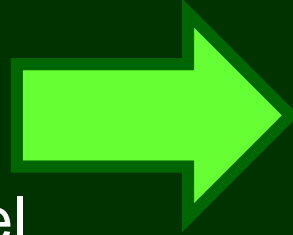


- ✓ Geospatial data summarized per NHD+ catchment
- ✓ Immediate and upstream aggregations used.
- ✓ Used 192 previously sampled locations (chemistry, biology, passive sampler) compiled and related to landscape indicators (308 variables)

Gordon, S.E., Jones, D.K., Williams, B.M., and Wright, Christopher, 2017, Potential contaminant sources and other landscape variables summarized for NHDPlus Version 2.1 catchments within the Chesapeake Bay Watershed: U.S. Geological Survey data release, <https://doi.org/10.5066/F7SQ8ZB3>

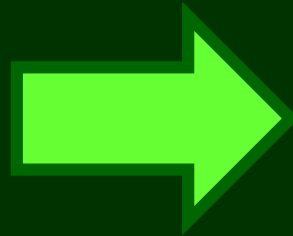
What are the relations with landscape predictors and flow?

✓ Of the 171 chemicals measured across sites, we had enough concentration data to effectively model 7 compounds



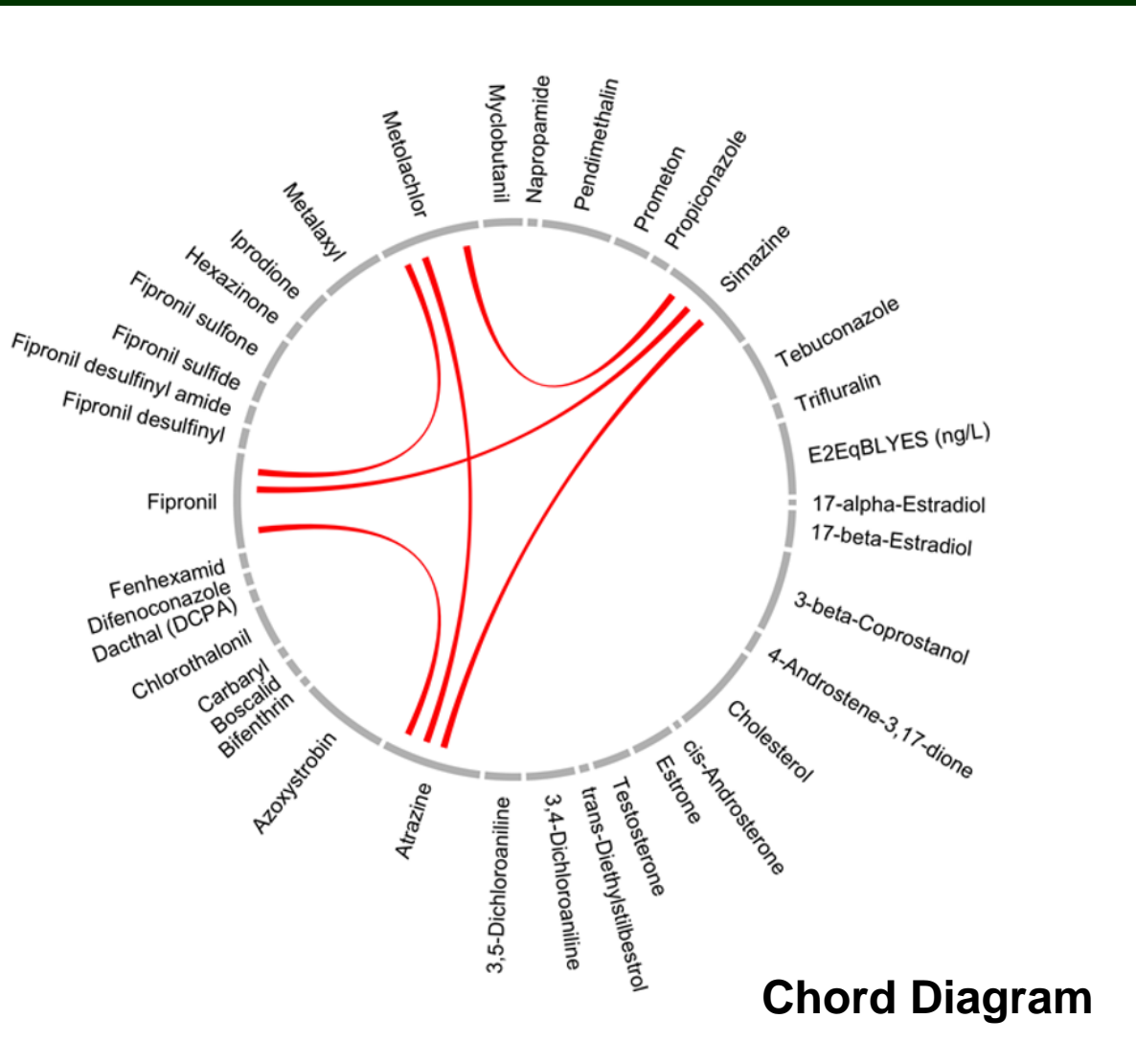
Atrazine, metolachlor (herbicides), formononentin, equol, genistein (phytoestrogens), cholesterol and estrogenicity

✓ Used general linear models to establish relationships with flow and selected landscape variables



% cultivated, developed, forested, mean phyto crops, biosolid application, mean atrazine application, mean metolachlor application

Co-occurrence of chemicals



- ✓ Used hierarchical modeling of presence/absence (>180 obs across sites) to look for significant residual correlations
- ✓ Modeled 37 contaminants including 9 hormones/hormone conjugates, 28 pesticides and estrogenicity
- ✓ Predictor variables were flow, percent ag and season

Preliminary data. DO NOT cite or distribute

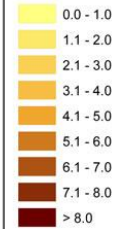
Can WQ management actions help minimize EDCs?

Agricultural Sources of Total Nitrogen

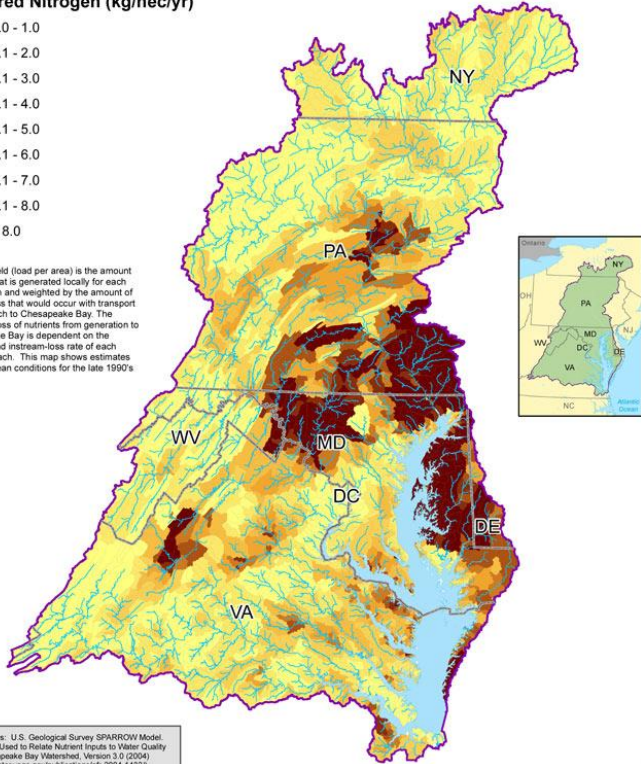
Delivered Yield to the Chesapeake Bay



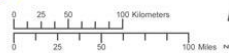
Delivered Nitrogen (kg/hect/yr)



Delivered yield (load per area) is the amount of nutrient that is generated locally for each stream reach and weighted by the amount of in-stream loss that would occur with transport from the reach to Chesapeake Bay. The cumulative loss of nutrients from generation to delivery to the Bay is dependent on the traveltime and in-stream-loss rate of each individual reach. This map shows estimates based on mean conditions for the late 1990's time period.



Data Sources: U.S. Geological Survey SPARROW Model
Digital Data Used to Relate Nutrient Inputs to Water Quality
in the Chesapeake Bay Watershed, Version 3.0 (2004)
(<http://hd.water.usgs.gov/publications/of-2004-1430/>)
For more information, visit www.chesapeakebay.net
Disclaimer: www.chesapeakebay.net/terms_of_use.htm



Created by JW, 2/12/08

UTM Zone 18N, NAD 83

- Flow and agricultural land-cover are primary predictor variables in modeling
- Flow tends to play a larger roll in the spring months when run-off events are more frequent and agricultural activity increases.
- BMPs designed to reduce nutrients under run-off events or high flow conditions could have similar positive effects on some EDCs

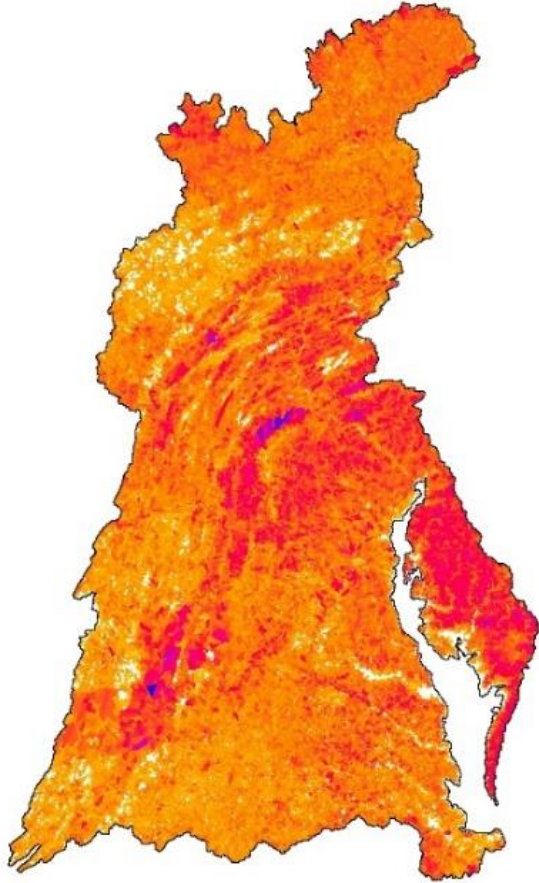
Can WQ management actions help minimize EDCs?



- Phytoestrogens observed frequently in the watershed but effects on fish health are currently unknown
- Major sources include soybeans, red clover and animal feeding operations
- Red clover planted as a cover crop to fix nitrogen, protect the soil erosion in the winter could be a major source to the watershed esp during the early spring.

Outcomes

Final Rank



- ✓ Identification of dominant sources of agricultural contaminants and landscape predictor variables
- ✓ Modeling co-occurrence and documenting relations with flow and land-use
- ✓ All to inform management actions to improve WQ and ultimately habitat quality and fish health



Available resources

Phillips, P.J., Scott, T.-M., Smalling, Kelly, and Kolpin, D.W., 2017, Hormone, pesticide, pharmaceutical and other organic compound data for select water and bed sediment samples collected in Chesapeake Bay watershed in parts of Maryland, Pennsylvania, Virginia, and West Virginia, 2006-2014: U.S. Geological Survey data release, <https://doi.org/10.5066/F73T9FD0>.

Iwanowicz, L.R., Ciparis, Serena, Blazer, V.S., Young, John, Pinkney, Alfred, Sperry, Adam, Lookenbill, Josh, and Mullican, John, 2017, Estrogen equivalents of surface water in the Upper Chesapeake Bay Watershed (2008 - 2011): U.S. Geological Survey data release, <https://doi.org/10.5066/F7MG7NGT>

Gordon, S.E., Jones, D.K., Williams, B.M., and Wright, Christopher, 2017, Potential contaminant sources and other landscape variables summarized for NHDPlus Version 2.1 catchments within the Chesapeake Bay Watershed: U.S. Geological Survey data release, <https://doi.org/10.5066/F7SQ8ZB3>

Blazer, V.S., Braham, R.P., Iwanowicz, L.R., Walsh, H.L., Hedrick, J.D., Mullican, J.E., Smith, G.D., Reeser, S.J, and Pinkney, A.E., 2018, 2004-2010 Chesapeake Bay Smallmouth and Largemouth Bass Estrogenic Biomarker Data: U.S. Geological Survey data release, <https://doi.org/10.5066/F7CF9P97>

QUESTIONS?

FOR MORE INFORMATION

ksmall@usgs.gov

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Biology Program

[https://www.usgs.gov/science/mission-
areas/environmental-health](https://www.usgs.gov/science/mission-areas/environmental-health)