Geospatial reconnaissance of endocrine disruption sources in the Chesapeake Bay

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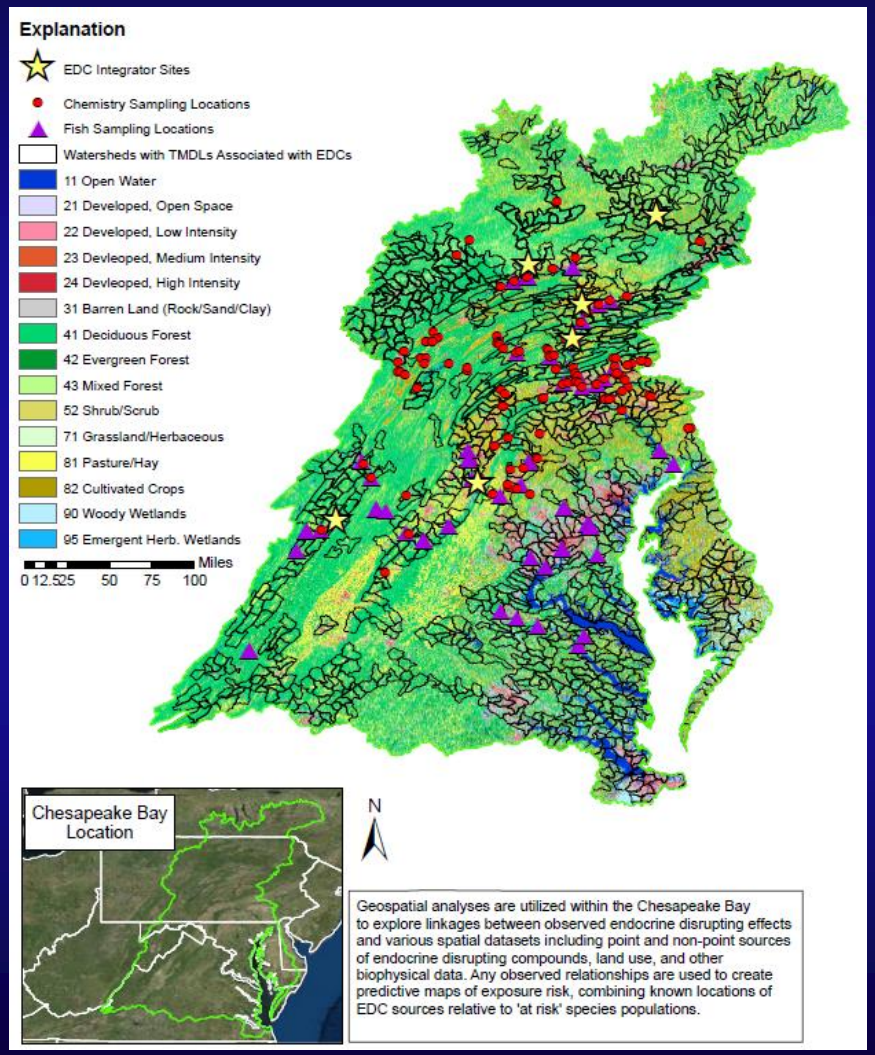
U.S. Department of the Interior
U.S. Geological Survey

Toxic Contaminants Workgroup Call

01/10/2018

EDC research in the Chesapeake Bay

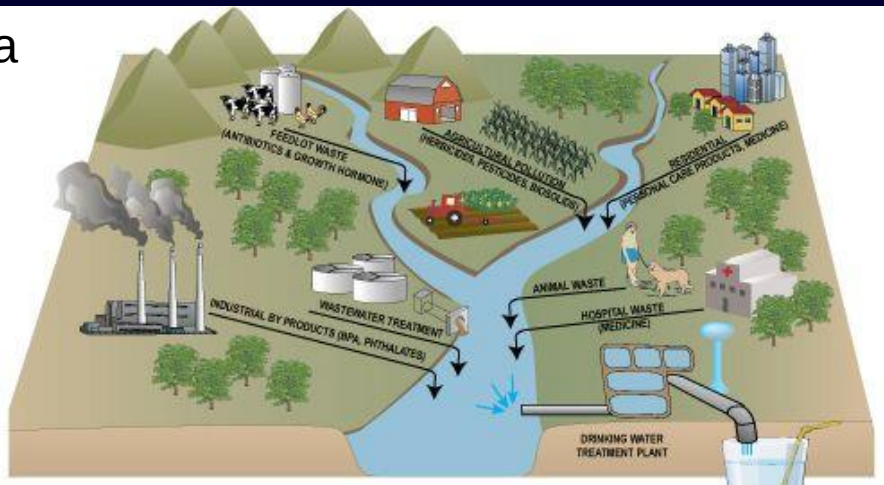
- **192 sample locations throughout the Bay**
  - Fish health, chemistry, estrogenicity, passive samplers
  - Multi-year and integration sites
- **Understand the occurrence, distribution, and sources of EDCs in the Bay and determine their ecological and human-health effects.**



Objectives

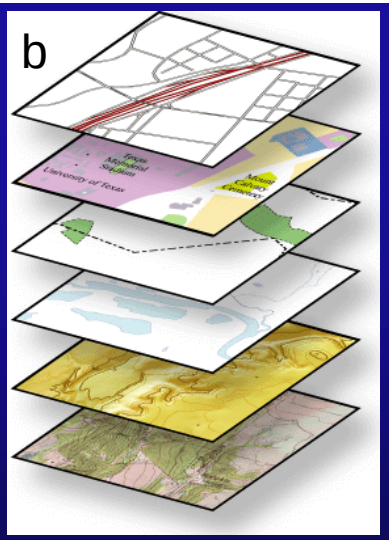
- Mapping of potential EDC sources and receptor species (FY16-17)
  - doi.org/10.5066/F7SQ8ZB3
- Chemical and Biological Synthesis (FY17-18)
- Model exposure threat at watershed-scale (FY18)
- Identify scalar relationships to help inform site-specific models (FY18-19)
  - Bay → Catchment → Reach → Organism

a

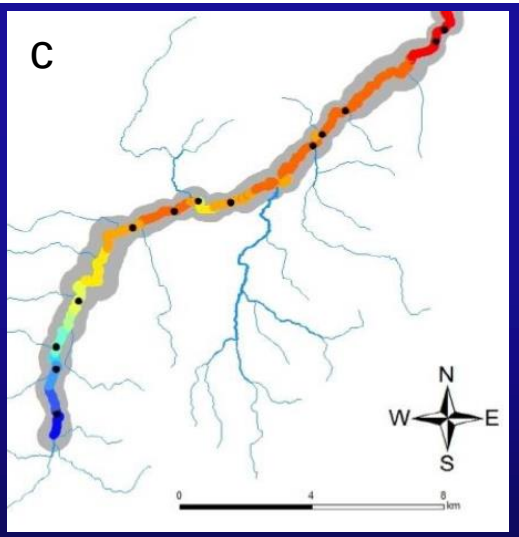


There are many sources of contaminated wastewater: municipal wastewater treatment plants, on-site waste disposal facilities, hospitals, livestock, poultry and fish production facilities. Contamination continues in smaller concentrations via runoff from impervious surfaces (e.g., roads), and from contaminated sediment, including runoff from areas where treated water and/or residual biosolids from wastewater treatment are applied.
Source: EPA. Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

b



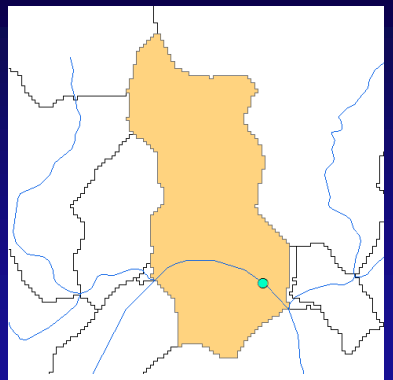
c



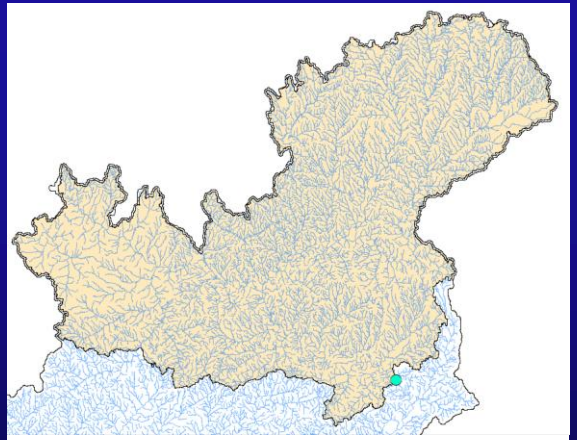
a - http://static1.squarespace.com/static/52260563e4b0e56a47d7efa6/t/527bc001e4b04a4b5511528f/1383841793424/pc_sonr_11+09+09+lr1.pdf
b - http://help.arcgis.com/en/arcgisdesktop/10.0/help/00v2/GUID-5BD98316-8BF4-430C-BA24-F47EFF8BF66D-web.png
c - http://www.fs.fed.us/rm/boise/AWAE/projects/stream_temp/downloads/14MaineStreamStatsOverview_Isaak.pdf

Data release - doi.org/10.5066/F7SQ8ZB3

- **262 variables summarized per NHDPlus V2.1 Catchment**
  - Summarized at the immediate and upstream catchment-scale
  - COMID can be used to related to NHDPlus available www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php
- **Additional landscape data available from NAWQA via doi.org/10.5066/F7765D7V**
  - climate, geology, soils, water balance, landscape characteristics, population demographics, infrastructure, topographic characteristics

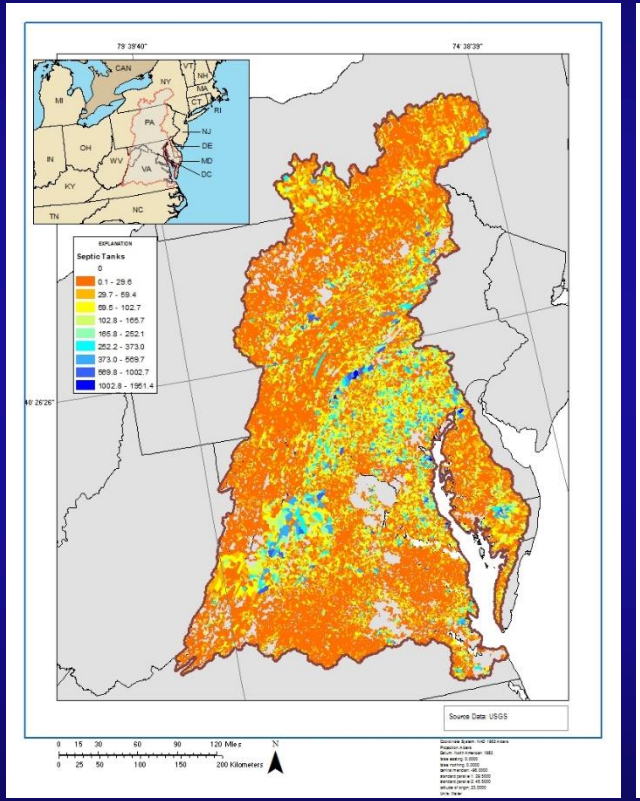


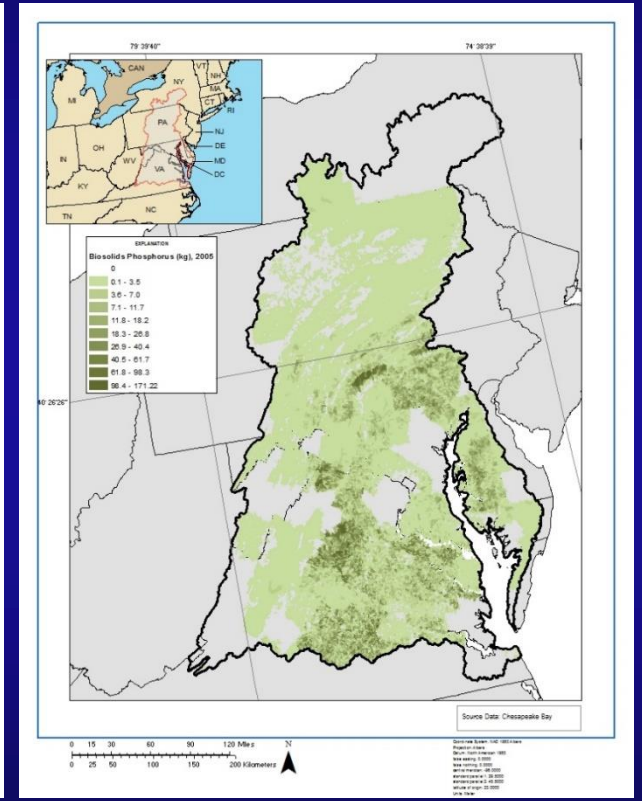
Immediate Catchment



Upstream Catchment

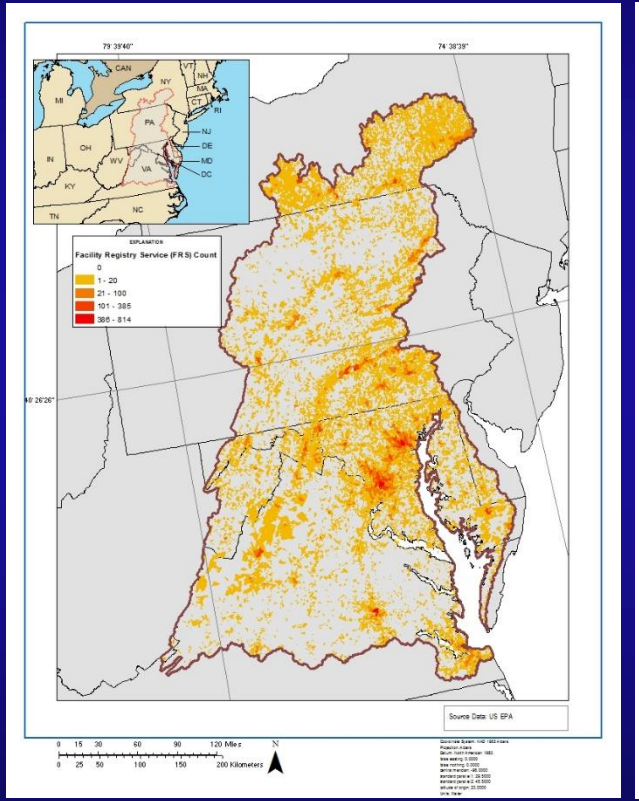
Data release – Waste and Wastewater

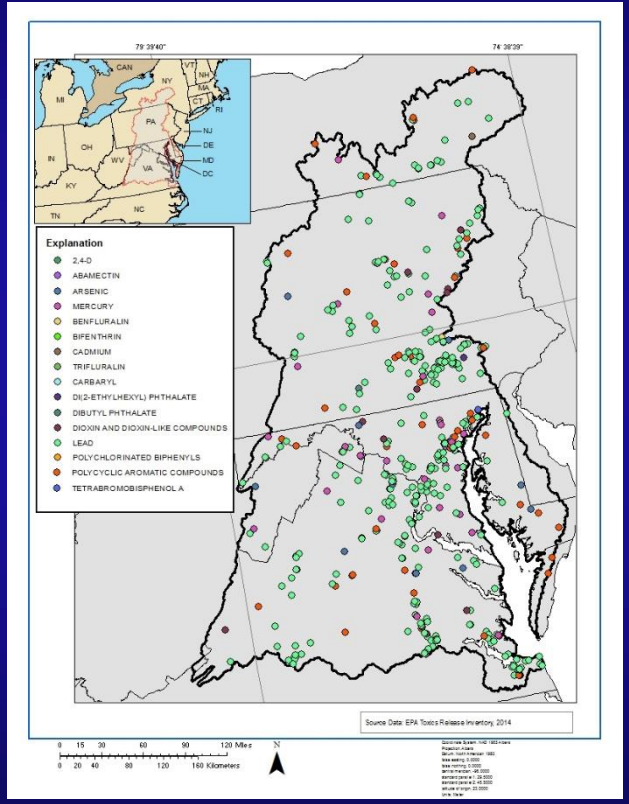




- **Septic (5)**
  - Estimated septic densities (Claggett)
  - EPA Septic Systems (active, abandoned, plugged)
- **Biosolid applications (22)**
  - CB Midpoint Assessment
  - N & P estimates 2003-2013
- **CSOs (1)**
- **Landfills (1)**

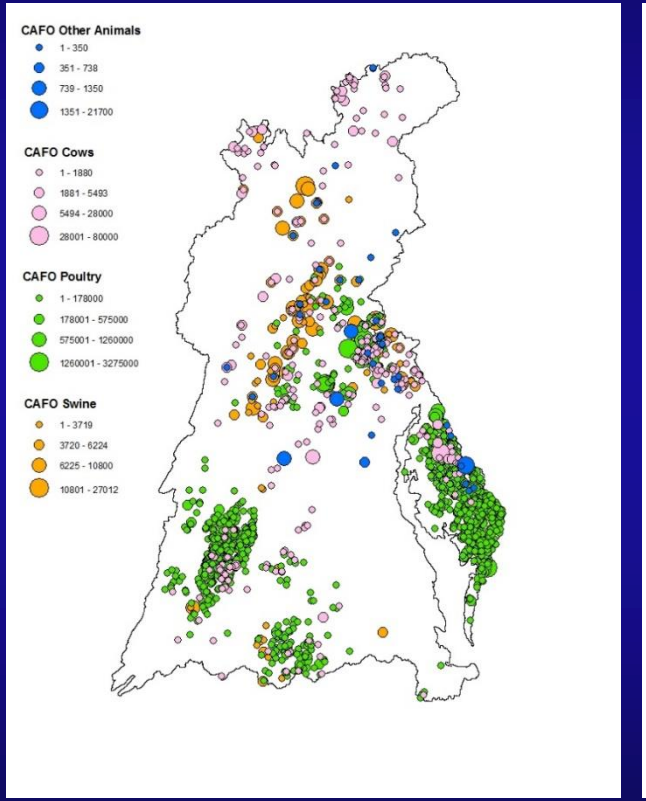
Data release – Regulated facilities and outfalls

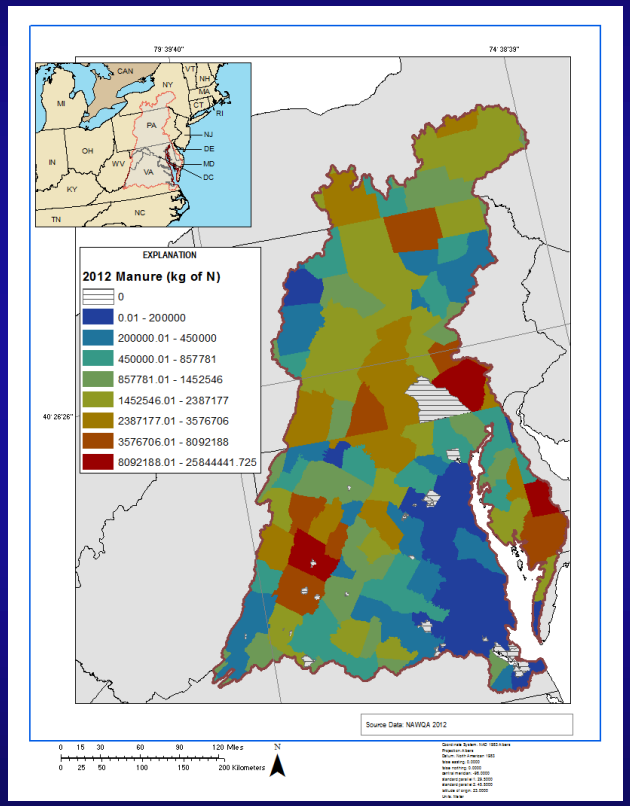




- **Toxic Release Inventory (1)**
- **Facility Registry Service (1)**
- **Discharge Monitoring Report outfalls (4)**
  - Federal
  - Publicly and Non-Publicly Owned Treatment Works

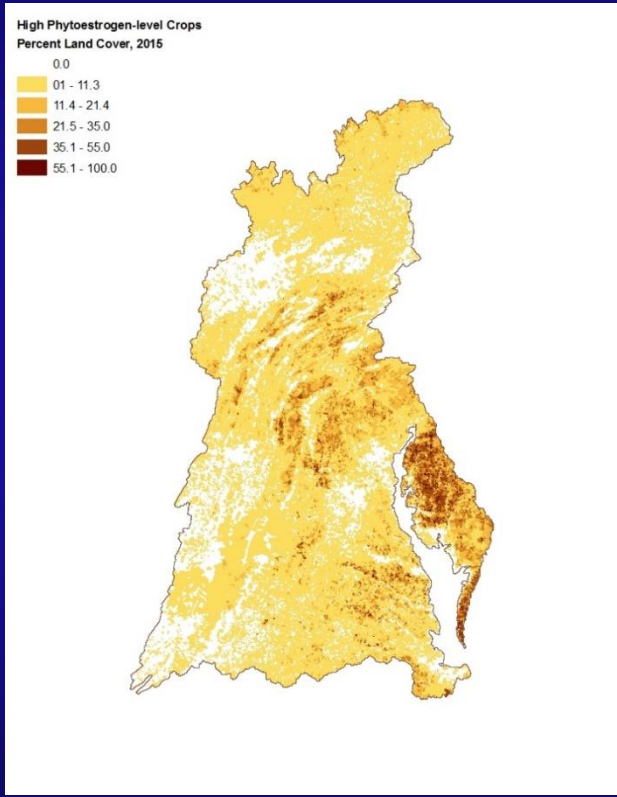
Data release – Agriculture

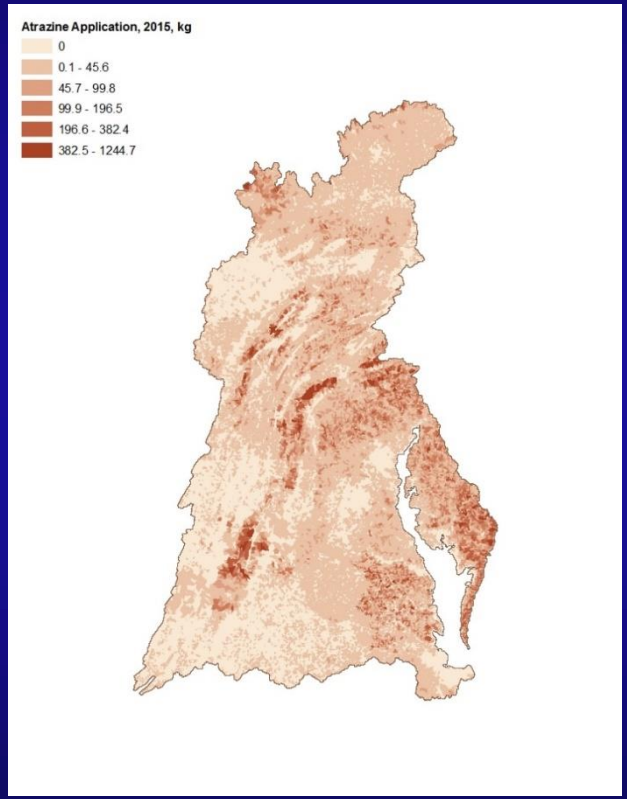




- **AFO headcounts (5)**
  - Cows
  - Poultry
  - Swine
  - Other Animals
- **Nutrients from manure, per animal class (34)**
  - N & P estimates from USDA Census of Agriculture (Sekellick)
  - 2002, 2007, 2012
  - Grassland, herbaceous, and pasture/hay only

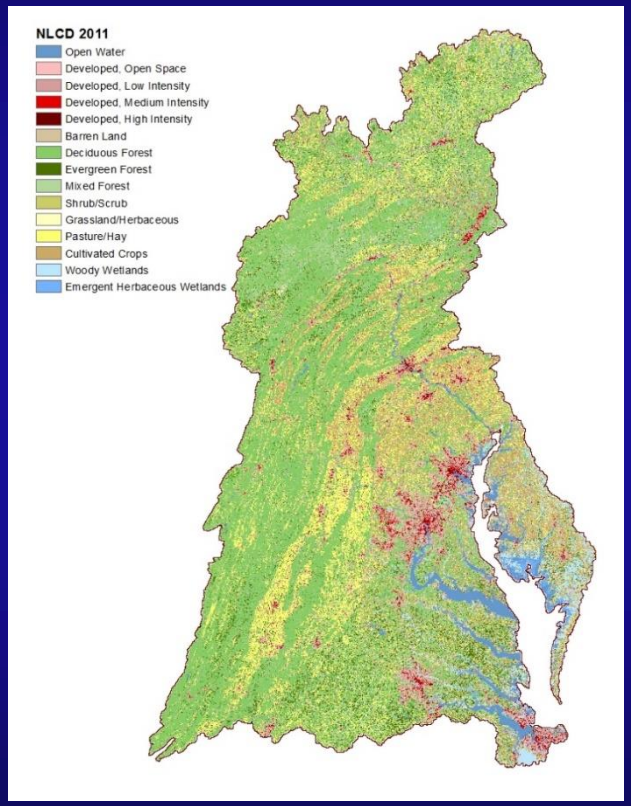
Data release – Agriculture

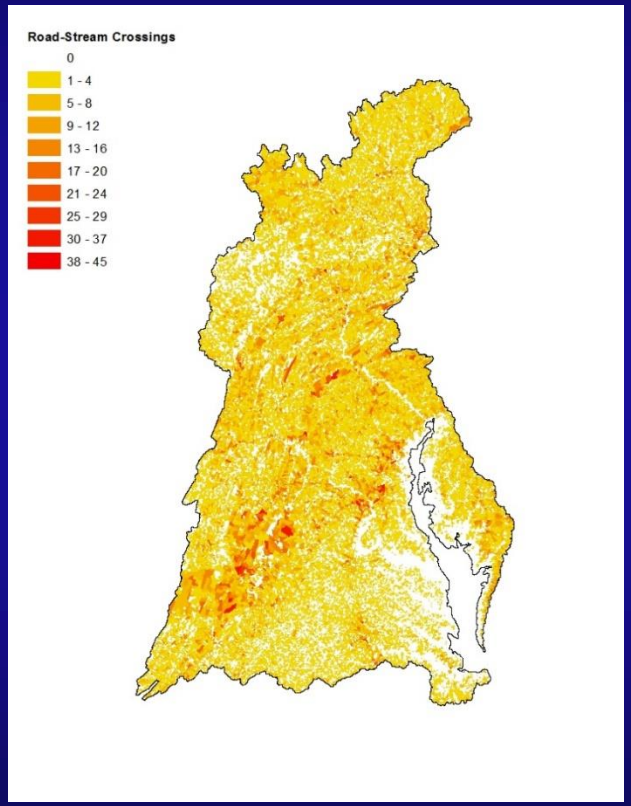




- **Phytoestrogenic crops (9)**
  - USDA Cropland Data Layer
  - 2002, 2008-2015
- **Pesticide applications (129)**
  - NAWQA Pesticide National Synthesis Project (Baker & Stone, 2015)
  - 2001, 2003-2015
  - Crop-specific use - Atrazine, Bifenthrin, Clothianidin, Fipronil, Imidacloprid, Metalaxyl, Metolachlor, Simazine, Thiamethoxam
  - Crop and pasture use - 2,4-D, Glyphosate

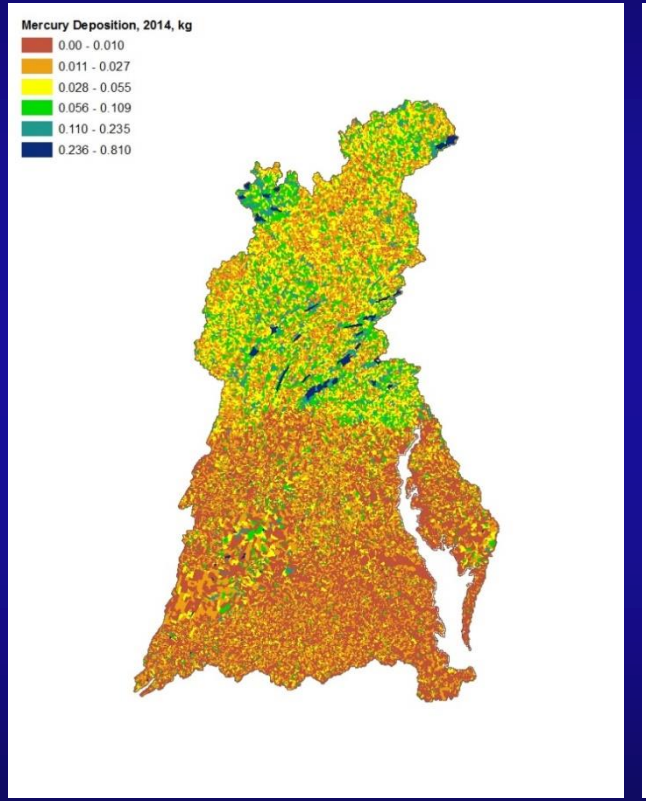
Data release – Land cover

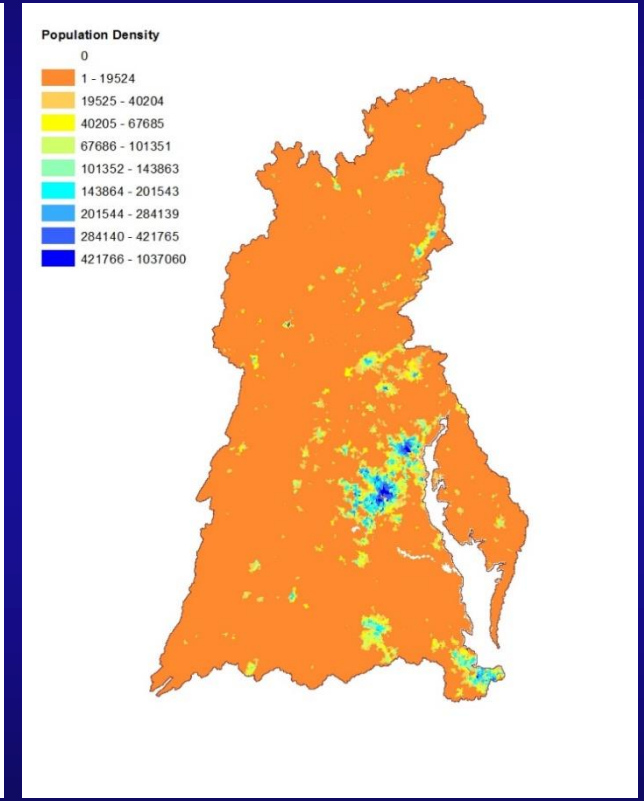




- **Anderson classes (33)**
  - 2001, 2006, 2011 NLCD
  - Change 2001-2011
- **Imperviousness (57)***
  - NAWQA NHD+ summaries (Schwarz and Wieczorek, in review)
  - Percent imperviousness (2001, 2006, 2011)
  - Stream-road crossings and Road densities from 2013 Tiger Road lines

Data release – Mercury and population

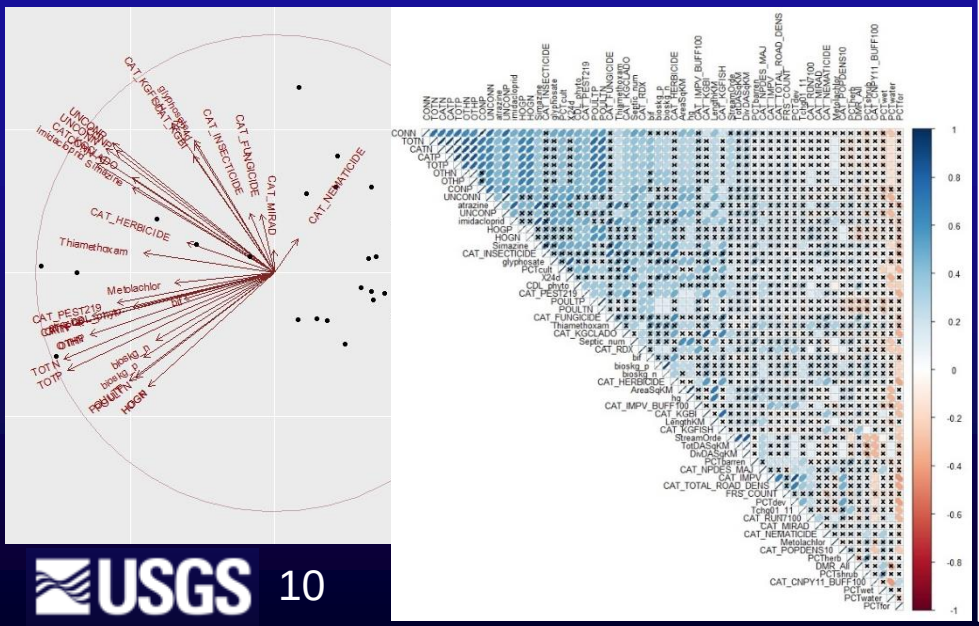




- **Mercury deposition (12)**
  - National Atmospheric Deposition Network
  - 2003-2014
- **Population (3)**
  - 2010 Census block data
  - Falcone, 2016

Chemical and Biological Synthesis

- **Explore correlations and landscape gradients (Young et al. 2014)**
  - PCA, Correlation Matrices
- **Quantify relationships with sampling data**
  - CART, WoE



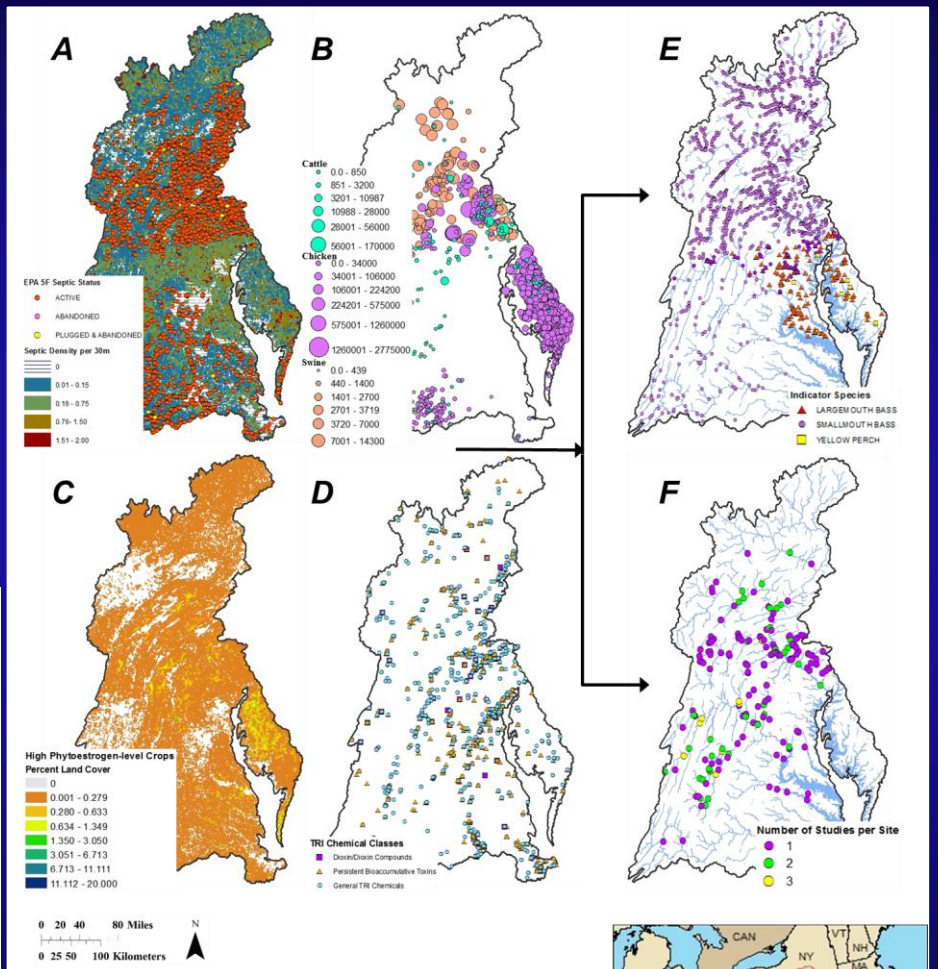
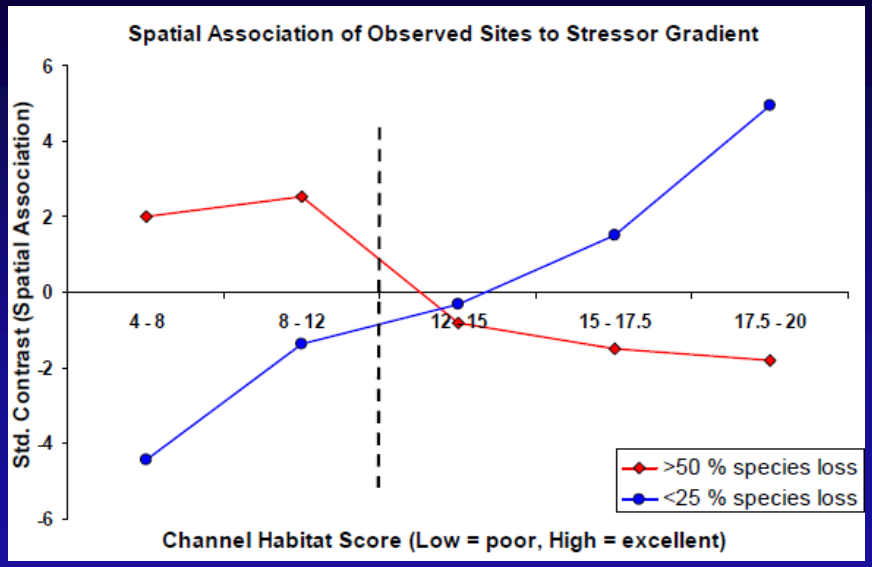
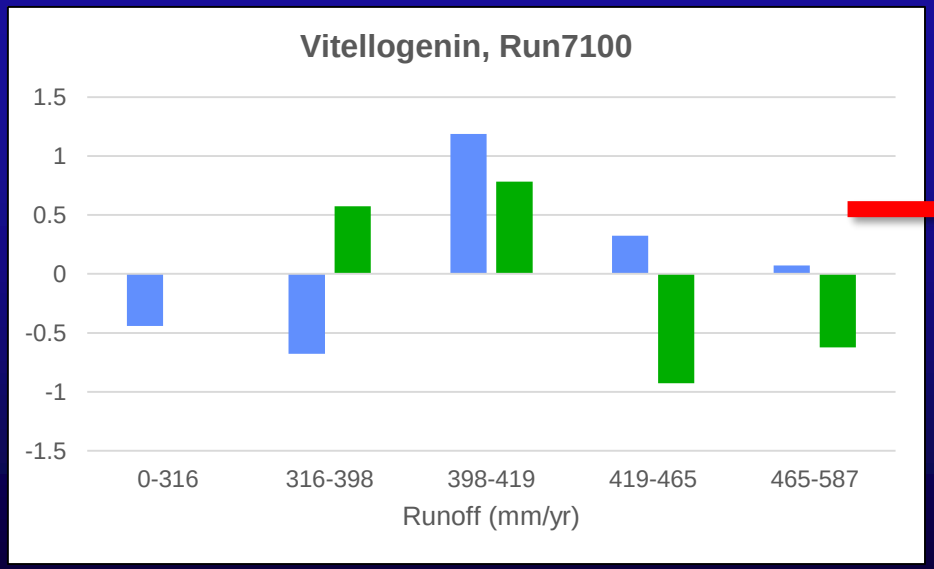


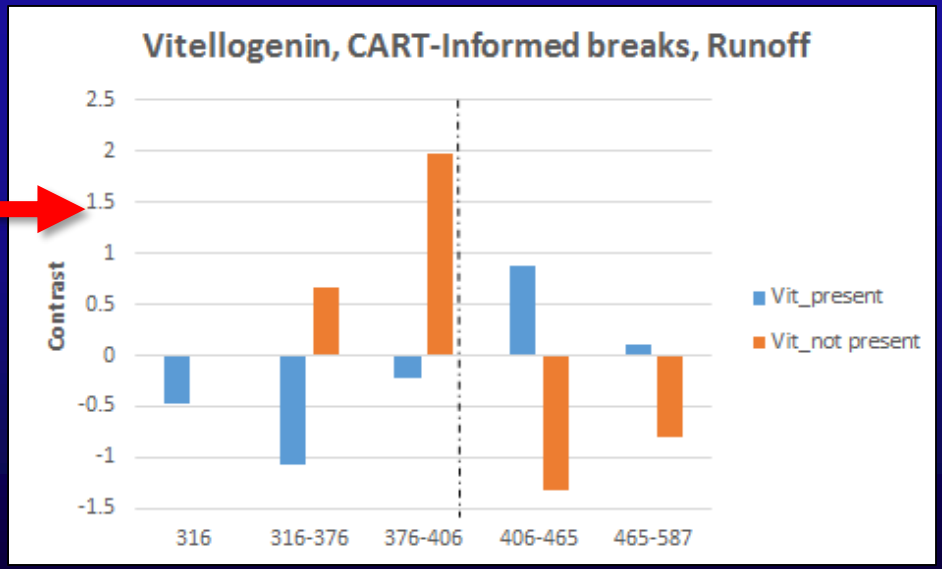
Figure 4. Mapped sources of potential EDCs (A-D) are summarized per NHDPlus catchments[3] and related to species assemblages (E) and sampling locations (F). Principal component analysis (PCA) and classification and regression trees (CART) are used to explore relationships between EDC sources and observed chemical and biologic effects data.

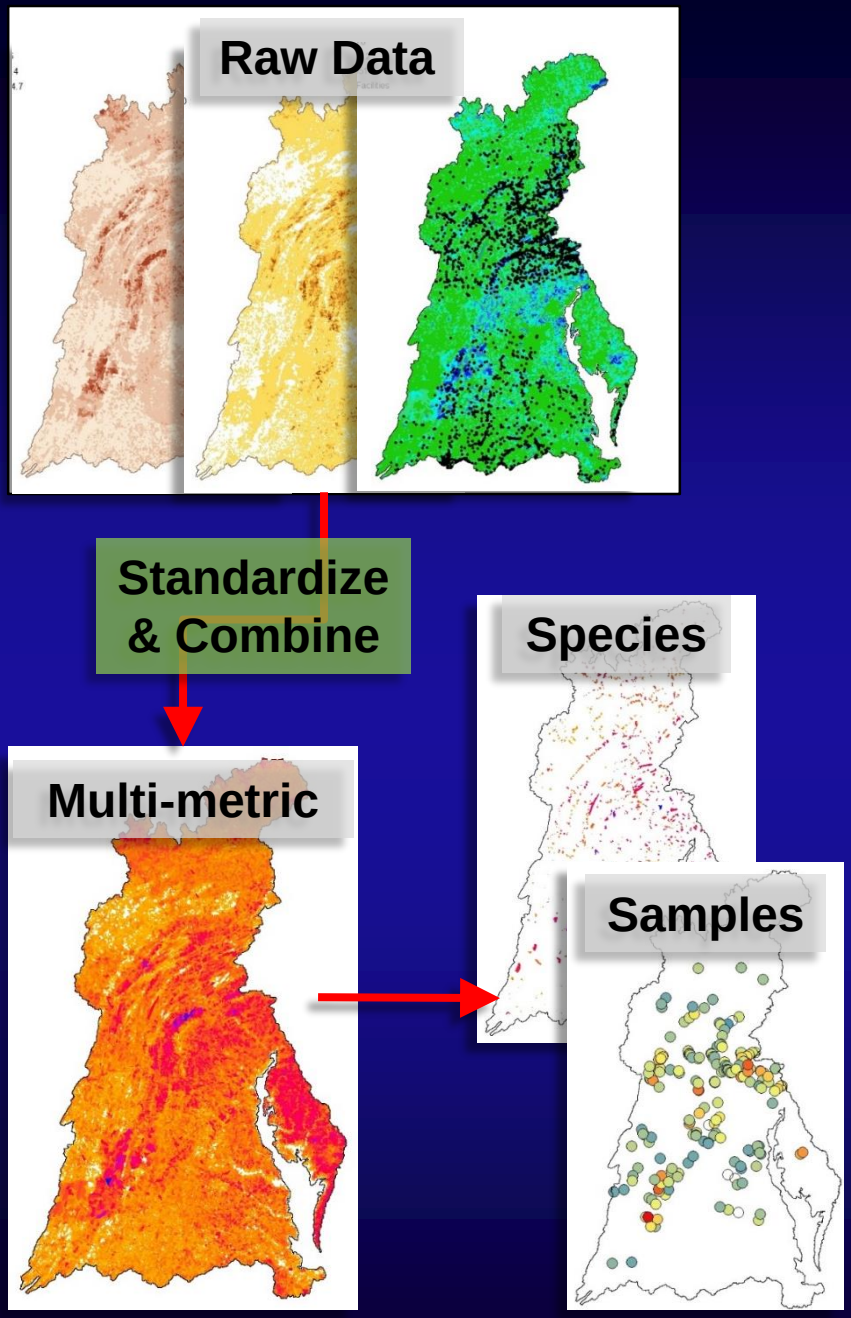
Current Status

- **Break lines define change point in response**
  - Occurrence of estrogenicity, vitellogenin, intersex
- **CART-based breaks used to refine WoE**
- **Currently working through variables in upstream catchments**









EDC Exposure Risk

- **Variable reduction via PCA and Correlation analyses**
  - Key variables and weights informed by synthesis work
- **Multi-metric for risk assessment**
- **Apply metric to samples, known species assemblages, habitat, etc.**

Anticipated products

- **Synthesis journal article documenting relationship between biological data and spatial variables**
- **Journal article detailing Bay-wide spatial work**
- **Maps of key EDC sources**
  - Change thresholds shown where appropriate
- **Visualizations, approved presentation, web application?**

Questions?

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- **Brianna Williams:**
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- **Data**
  - Gordon et al., 2017, Potential contaminant sources and other landscape variables summarized for NHDPlus Version 2.1 catchments within the Chesapeake Bay Watershed, https://doi.org/10.5066/F7SQ8ZB3.
  - *Wieczorek et al., 2017, Select Attributes for NHDPlus Version 2.1 Reach Catchments and Modified Network Routed Upstream Watersheds for the Conterminous United States, https://doi.org/10.5066/F7765D7V.
  - NHDPlus Version 2.1 - http://www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php

*Data is provisional and subject to change