Agricultural best management practices can improve water quality and conditions for fisheries in the Chesapeake Bay Watershed

Issue: Partners in the Chesapeake Bay Program (CBP) are implementing best management practices (BMPs) to prevent nutrient and sediment from entering waterways across the Chesapeake watershed and reduce loads to the Bay. In addition to reducing nutrients, CBP partners want to better understand how BMPs can provide additional benefits for addressing toxic contaminants, such as pesticides, hormones, and pathogens. Agricultural land use and activities (manure application, pesticides use, phytoestrogens in crops) are known to contribute compounds to surface waters that disrupt normal hormone function in organisms. High levels of estrogenic activity have been observed to adversely affect fish and are linked to effects including intersex in male fish, increased susceptibility to immunosuppression and parasites or lesions, and potential population-level effects. An effects-based threshold of 1.0 ng/L has been used to categorize low and high levels of estrogenic activity in relation to fish health.

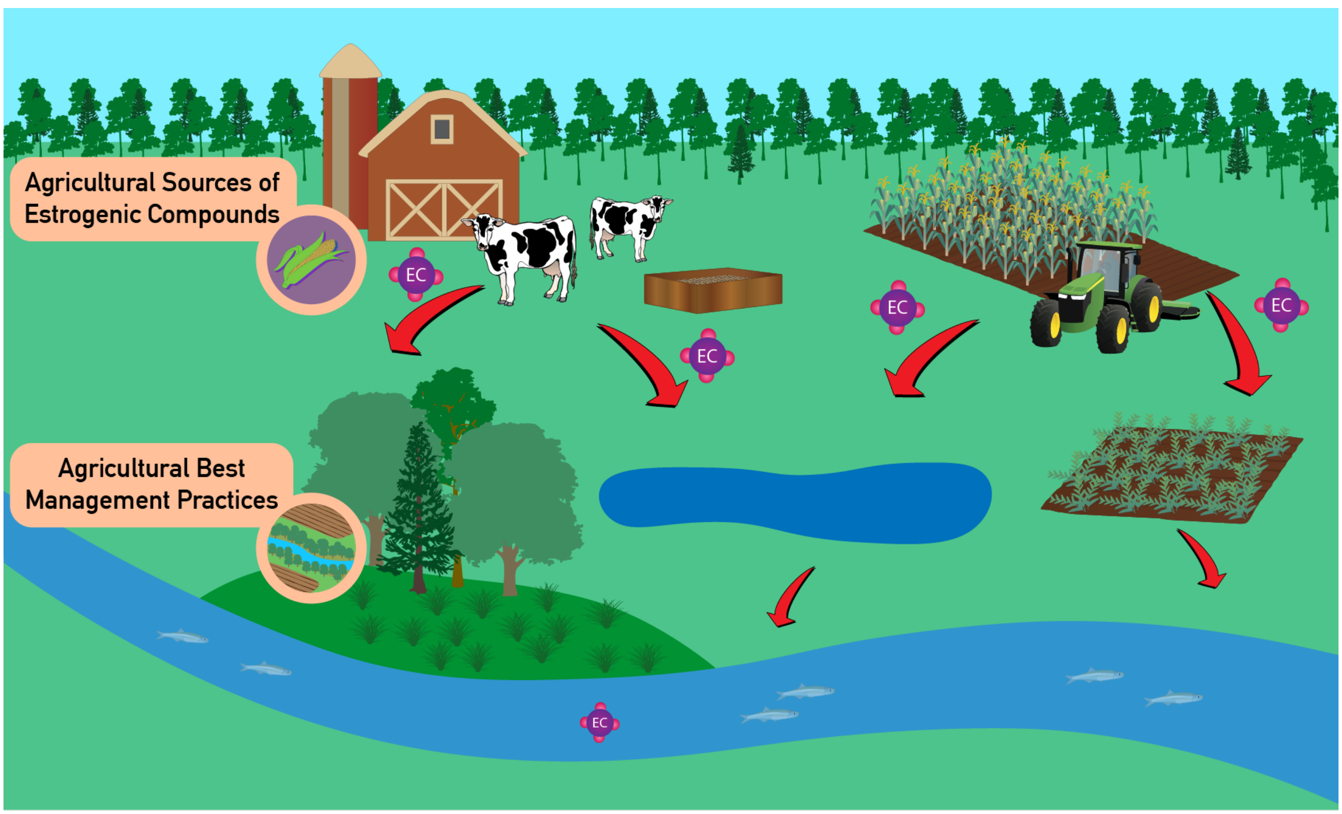

Figure 1. Agricultural sources of estrogenically active compounds typically include animal waste and pesticides. These compounds can be reduced by using agricultural Best Management Practices (BMPs) such as riparian buffers retention ponds and cover crops, which are being implemented to address nutrients and sediment.

USGS Study: The study focused on gaining a greater understanding of the role of BMPs and other important variables potentially linked to lower levels of estrogenic activity concentrations in agricultural watersheds of the region.

Estrogenic activity concentrations were compiled to create a spatially and temporally robust dataset containing 244 unique sites (841 total samples) collected from 211 NHDPlus version 2.1 catchments across the Chesapeake Bay Watershed (CBW). Sites were characterized based on landscape data representing known and potential sources of estrogenic activity and matched to sampling dates for analysis (Figure 2).

BMPs known to improve water quality were chosen to generate a BMP intensity metric, quantified as acres of BMPs per acres of agricultural land cover. Statistical modeling was used to evaluate the potential effects of landscape and climate factors on estrogenic activity concentrations.

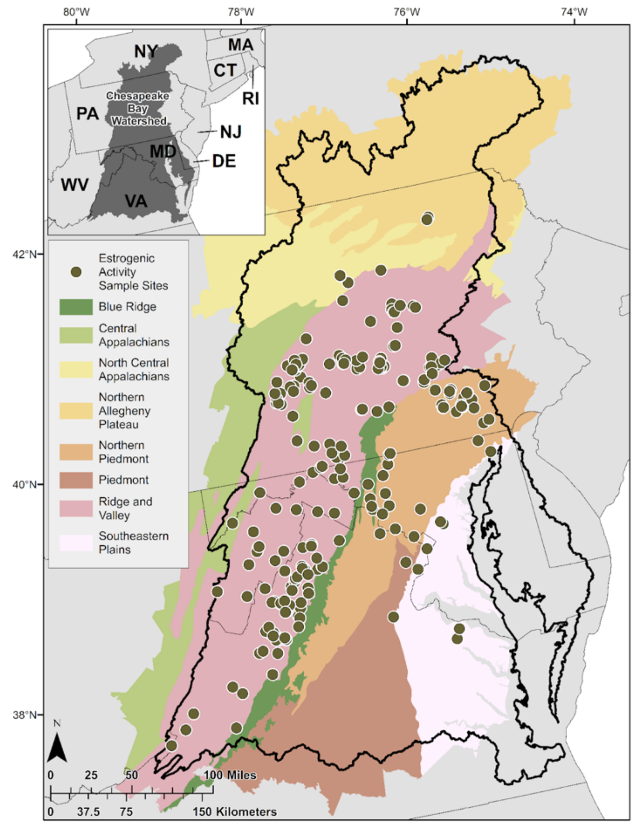

Figure 2. Surface water sampling locations (n = 244) in the Chesapeake Bay Watershed shown with EPA Level 3 Ecoregions.

Major findings: The analysis determined key relationships between BMP intensity and type, agricultural landuse, and estrogenic activity. Some of the major findings were:

- **Areas of intense agricultural landuse had the highest levels of estrogenic activity**. The study found that areas dominated by agricultural land use, but a low number BMPs, had the highest levels of predicted estrogenic activity (condition shown on the right-hand portion of Figure 3).
- **Implementing BMPs in agriculturally dominated areas results in reduced levels of estrogenic activity**. BMP implementation in high-agriculture areas has the potential to reduce estrogenic activity to that of low-agriculture areas (Figure 3). The study results predicted a substantially lower level of estrogenic activity when BMPs were implemented on lands with high agricultural land use. However, high implementation of BMPs on lands not dominated by agriculture did not reduce estrogenic activity.
- **Wetlands may also reduce estrogenic activity in water**. Results from the study indicate a negative relationship between estrogenic activity and wetlands. Studies have shown that constructed wetlands can reduce estrogenic endocrine disrupting compounds (EEDCs) through multiple mechanisms including microbial degradation, sorption to sediment, uptake into plants/animals, photolysis, and hydrolysis.

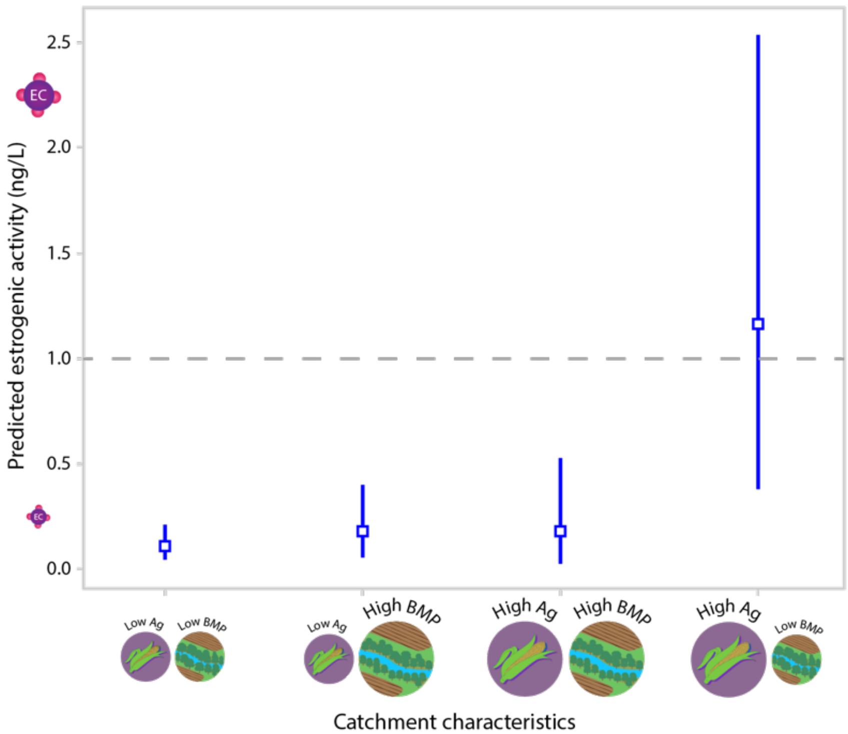

Figure 3. Predicted estrogenic activity concentrations at different combinations of low and high agricultural land use (Ag) and best management practice intensity (BMP) in the upstream watershed. "Low" and "high" correspond to the minimum and maximum values observed in the dataset. Squares are means and vertical bars are 90% credible intervals. Dashed line represents the 1.0 ng/L effects-based threshold (EBT). Figure adapted from Gordon et al 2022.

Management implications/applications: The study provides managers with a broader perspective on the importance of BMPs, especially in agricultural watersheds, to achieve healthier waters.

Farm fields are separated by forest buffers from the West Branch Susquehanna River in Clinton County, Pennsylvania. Photo by Will Parson/Chesapeake Bay Program (Flickr CC BY-NC 2.0)

- Focusing BMP implementation to address nutrients in agriculturally dominated watersheds likely provide additional benefits to reduce toxic contaminants and improve conditions for fisheries.
- While this study focused on agricultural lands, BMPs in urban landscapes may also contribute to reducing toxic contaminants and improving fish health.
- Results from this study add to the growing amount of research indicating the potential of agricultural BMPs to reduce estrogenic activity in local surface waters, thereby improving water quality on more regional scales.

For more information:

- Publication title: Estrogenic activity response to best management practice implementation in agricultural watersheds in the Chesapeake Bay watershed

- Publication URL (with supplementary information): https://doi.org/10.1016/j.jenvman.2022.116734

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- This science summary was prepared in collaboration between the USGS and the University of Maryland Center for Environmental Science, Integration and Application Network. More information on UMCES-IAN can be found at: https://ian.umces.edu/

- Web version: https://www.usgs.gov/centers/chesapeake-bay-activities/science/agricultural-best-management-practices-can-improve-water

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