Workshop Overview:

The Scientific and Technical Advisory Committee (STAC) of Chesapeake Bay Program (CBP)

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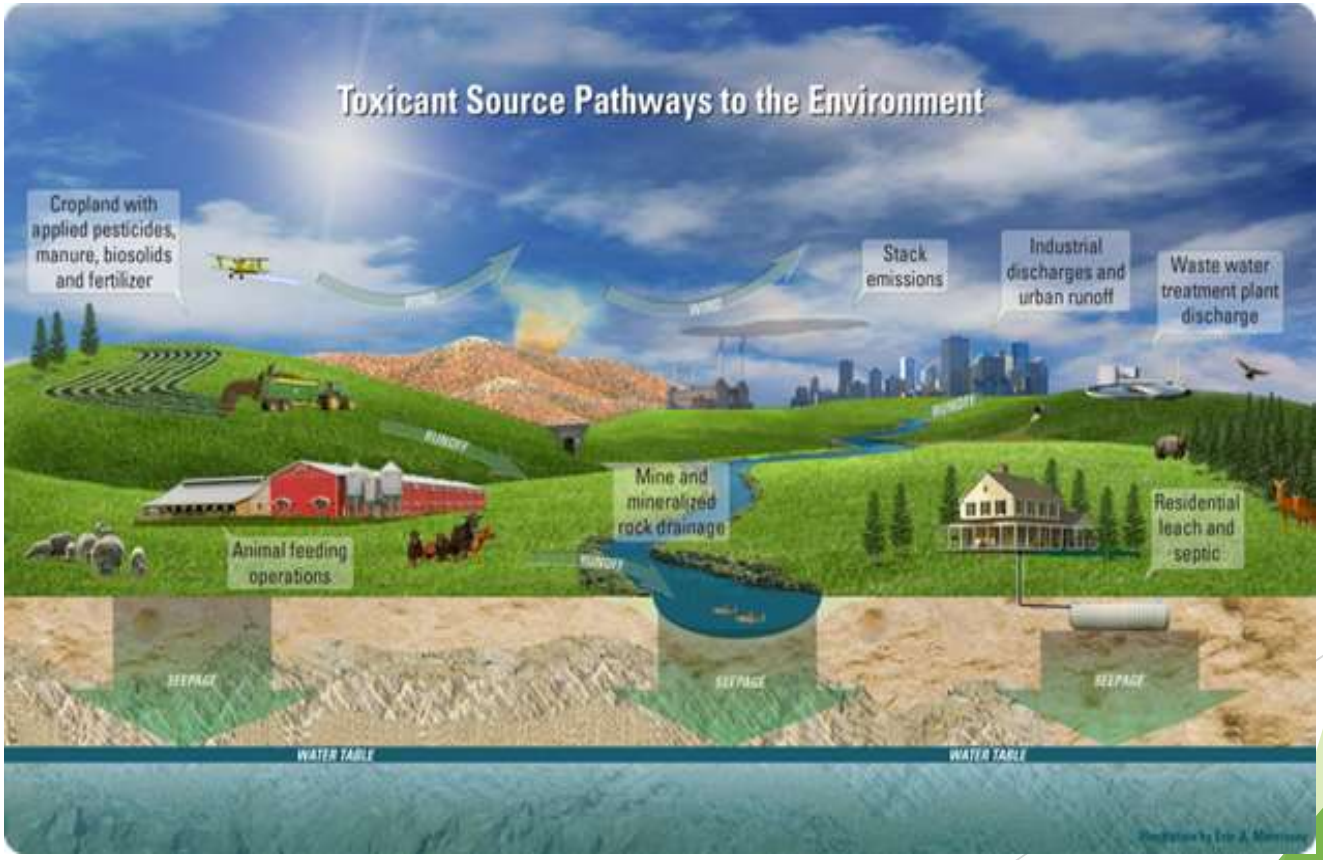
Integrating Science and Developing Approaches to Inform Management for Contaminants of Concern in Agricultural and Urban Settings



Objectives of the workshop

- Review major findings of toxic contaminants in agricultural and urban settings and how these are impacting
    - Fish consumption advisories
    - Fish health
- Summarize the understanding of the sources, transport, fate, and effects of chemicals of concern
- Present how to mitigate effects of chemical contaminants by taking advantage of already implemented practices for nutrient and sediment reduction
- Identify future research needs

Fish consumption advisories (FCA)

States recommend meals-per-month limits based on specific contaminant risks to human health

- In DC, according DDOEE, contaminant concentrations appear to be trending downward
- In MD, Bay-wide FCA were primarily driven by PCBs: advisories range from “no consumption” to “8 meals per month”
- In Pennsylvania, about 21 percent of total stream miles have fish consumption advisories, primarily due to PCB levels
- West Virginia manages fish consumption advisories (due to PCBs, mercury & dioxins) are determined through a workgroup consisting of the Departments of Environmental Protection, Natural Resources, and Health and Human Resources
- In Delaware, concentrations of PCBs, mercury, dioxins/furans, and other contaminants have dramatically decreased due to mitigation efforts; consequently, the number and severity of consumption advisories have fallen in recent years

Fish health (urban settings)

- Fish exposed to mixtures of toxic contaminants (PCBs, legacy and current use of pesticides, PAHs, and emerging contaminants) and other stressors (low oxygen conditions, high temperatures, and bacteria)
- Two focus species:
  - Brown bullhead: Tendency to develop tumor (low susceptibility) and their linear home range of about 2 kilometers (site specificity)
  - Yellow perch: Reproductive health (In the most urbanized tributaries (Severn and South), eggs had a significantly higher percentage of abnormal yolks and thin, irregular egg envelopes)

Fish health (urban settings)

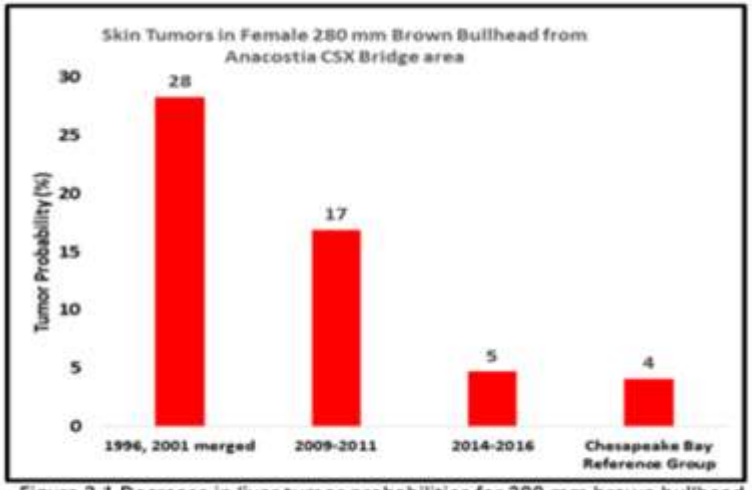


Figure 2.1 Decrease in liver tumor probabilities for 280 mm brown bullhead (Pinkney et al. 2019)

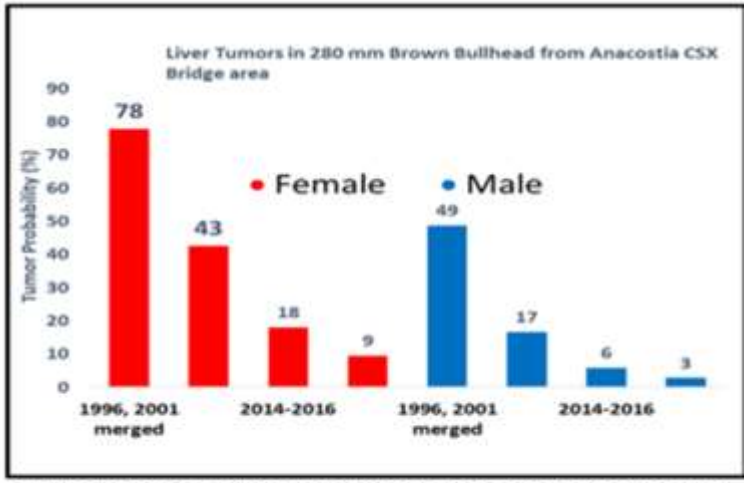


Figure 2.2 Decrease in skin tumor probabilities for female 280 mm brown bullhead from the Anacostia River (Pinkney et al. 2019)

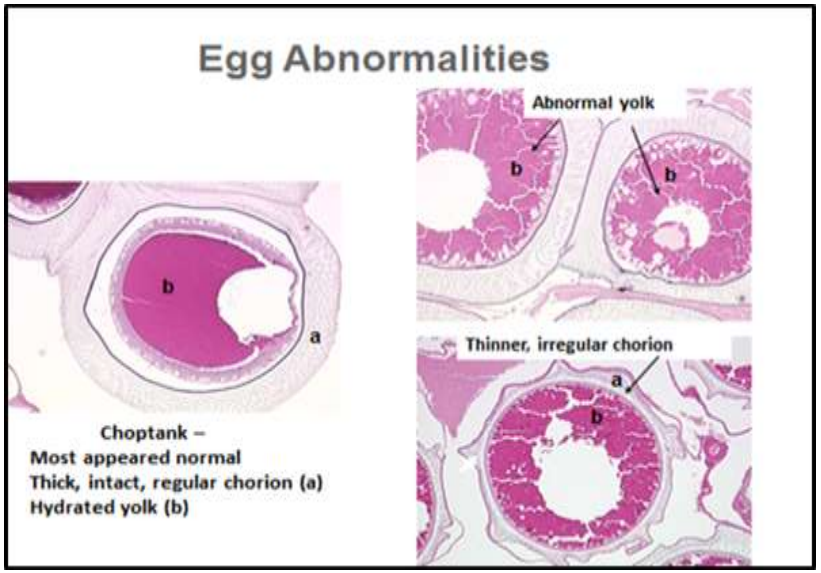


Fig. 2.3. Egg abnormalities observed more frequently in yellow perch from urbanized rivers (e.g., Severn) (from Blazer et al. 2013)

Fish health (agricultural settings)

- Concerns include fish kills, low chronic mortality, skin lesions, and reproductive endocrine disruption as evidenced by intersex (testicular oocytes) and vitellogenin (an egg yolk precursor) in male fishes
- Chemicals shown to induce intersex in other species: Estrogen, β-estradiol, atrazine, DDE, phytoestrogens, and metformin
- Chemicals lower disease resistance: Arsenic, PCBs, bifenthrin, pendimethalin, metolachlor, and mercury, can adversely affect disease resistance
- Linked to fish kill: Nutrients can increase bacterial loads

Sources, fate, and transport of contaminants of concern

- In agricultural settings: chemicals associated with land-application of manure and biosolids and pesticide application

- In urban settings: Polychlorinated biphenyls (PCBs), pharmaceuticals, personal care products, and polyfluoroalkyl substances (PFAS)

Studies and findings in urban settings

1. Source “fingerprinting” approach: Andy James (University of Washington) described high-resolution mass spectrometry approaches to build libraries of “unique” organic molecules
2. Concurrent field monitoring and modeling approach: Kevin Farley (Manhattan College) described efforts to remediate PCBs in the Hudson River
3. Ron MacGillivray (Delaware River Basin Commission) described contaminant levels in the Delaware River: (a) PFAS were widely present in the river, but concentrations decreased from 2007 to 2015 (b) PCB loads in the Delaware River have decreased since 2005, leading to changes in fish consumption advisories
4. Lee Blaney (UMBC) described a fingerprinting method to backtrack the source of the PCPs, antibiotics, hormones, UV-filters (used as sunblock in sunscreen creams) etc. into the Chesapeake Bay

Studies and findings in agricultural settings

1. The sources of contaminants on agricultural lands of the Chesapeake Bay Watershed are relatively well defined and include pesticide use (legacy or current), manure application, manure storage, biosolids application, irrigation of treated wastewater, and septic systems.
2. A continued need exists for more information on the exposure, distribution, and effects of newer and emerging toxic contaminants that includes antibiotics, engineered nanomaterials, flame retardants, metals, microfibers/plastics, natural and synthetic hormones, personal care products, PFAS, and pharmaceuticals.
3. Investigative studies are needed to understand contaminant interactions with sediment and organic carbon, transport to and from shallow groundwater, environmental degradation, and overall persistence in the environment.
4. The spatial and temporal variability of agricultural contaminants are currently being evaluated in a select number of subwatersheds; however, more information is needed for the entire Chesapeake Bay Watershed to understand the implications for the health of aquatic organisms during sensitive life-stages.

Mitigation and interactions of contaminants with nutrients and sediments

- Review of existing qualitative assessments of BMP impacts on toxic contaminants
- The BMPs classified as having the highest impact on toxic contaminants
- These are primarily agricultural BMPs and include forest and grass buffers, septic connections, shoreline management, amendments for the treatment of agricultural waste, animal waste management systems, barnyard runoff controls, and manure treatment technologies
- Some BMPs have negative effects; for example, cover crops are usually killed in the spring with herbicides, increasing the amount of toxic contaminants in runoff
- BMPs are classified by function in order to evaluate the overall impact on the landscape; classifications include reducing nutrient application, decreasing volatilization, implementing biofiltration and runoff control, and incorporating runoff control to streams

Mitigation and interactions of contaminants with nutrients and sediments

Mitigation approaches including watershed BMPs documenting A) PCB removal in bioretention cell (Kjellerup), B) Contaminants of Emerging Concern in iron-enhanced sand filter ponds (Keisling), and C) in-stream applications using bioamended granular activated carbon (Ghosh).

Future research needs

- Identified contaminants of concern in the urban and agricultural runoffs

- Summarized current knowledge on toxicity and effect on aquatic lives, fate and transport, treatment and remediation

Table 3.1

Contaminant Class	FCA?	Fish Health and other ecological Effects?	Conveyance (shared with N/P or S?)	Fate and Transport	Additional Research Needed
Known *(FCA and/or ecological effects threshold exceeded)*					
PCBs	Y	Y - fish health Reproductive Survival Trophic transfer Impacts on community structure	Stormwater (y) Wastewater (y) Atmospheric (N)		
PAHs	N	Larval toxicity Tumors Fish development, esp cardiac Benthic community	Stormwater (y) Atmospheric		
Dioxins/Furans	Y	Y - fish health Reproductive Survival Trophic transfer	Stormwater (y) Biosolids runoff Atmospheric		
Organochlorine pesticides	Y	Community impacts	Stormwater (y)		
Mercury	Y	Survival/mortality	Atmospheric Stormwater		
Metals (i.e. Pb, Cu, Zn, Cr, Al)	N	Larval mortality	Stormwater Atmospheric		Monitoring
Salts (chlorides)	N	Toxic to FW, benthic Impacts to benthic community	Stormwater Groundwater		Toxicity effects
Hydrocarbons	N	Larval toxicity Tumors Fish development, esp cardiac Benthic community	Stormwater Wastewater Groundwater		
Suspected *(presence and association with fish health effects)*					
PFAS	N	Little available data in CB	Groundwater Stormwater Atmospheric Wastewater		
Antibiotics	N	Little available data in CB	Wastewater (septic)		
Newer class pesticides (e.g., Neonicotinoids)	N	Little available data in CB	Stormwater		
Estrogenic hormones	N	Reproduction Immune suppression	Wastewater		
Plastics	N	Respiration in larval fish Mortality Impacts to zooplankton	Wastewater Stormwater Litter		
Triclosan/Triclocarban	N	Impacts to benthics	Wastewater		
UV filters	N	Little available data in CB - study in DE bay on horseshoe crabs	Wastewater Stormwater Recreation		
BPx (plasticizers)	N	Little available data in CB	Wastewater Stormwater Litter		

Future research needs

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Contaminant Class	FCA?	Fish Health and other ecological Effects?	Conveyance (shared with N/P or S?)	Fate and Transport	Additional Research Needed
Mercury	Y	Survival/mortality	Atmospheric Stormwater		
Metals (i.e. Pb, Cu, Zn, Cr, Al)	N	Larval mortality	Stormwater Atmospheric		Monitoring
Salts (chlorides)	N	Toxic to FW, benthic Impacts to benthic community	Stormwater Groundwater		Toxicity effects
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Thank You