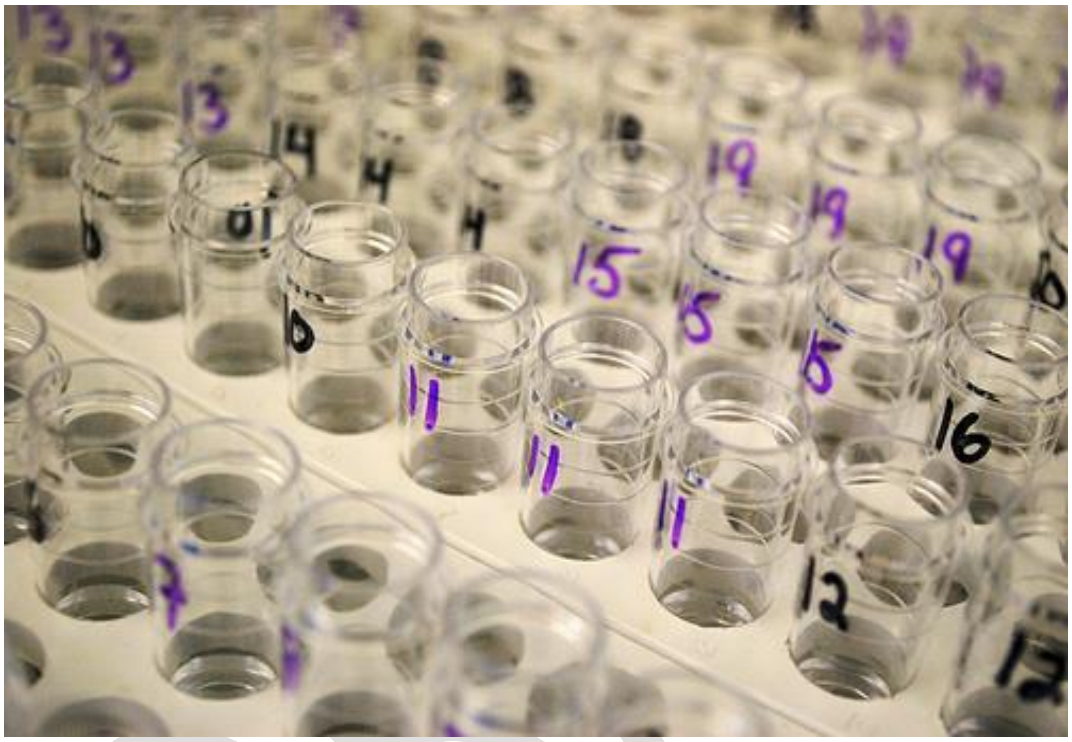
Toxic Contaminants Research Outcome

Management Strategy



Introduction

The Chesapeake Bay Agreement has a goal to ensure that the Bay and its rivers are free of effects of toxic contaminants on living resources and human health. The two associated outcomes are (1) research and (2) policy and prevention. The strategy for the research outcome will improve information about the occurrence, concentrations, sources and effects of toxic contaminants on fish and wildlife. The findings will be used by the CBP Toxic Contaminant Workgroup (TCW) and Water-Quality Goal Implementation Team to consider policy and prevention approaches to reduce the effects of contaminants on living resources in the Bay watershed and make them safer for human consumption. The issues being addressed in the research strategy have been updated in 2018 to be:

- Supply information to make fish and shellfish safer for human consumption;
- Understand the influence of contaminants degrading the health, and contributing to mortality, of fish and wildlife;
- Document the sources, occurrence, and transport contaminants in different landscape settings;
- Identify and prioritize options for mitigation to inform policy and prevention strategies,
- Gather information on issues of emerging concern

I. Goal, Outcome and Baseline

This strategy identifies approaches for making progress toward the toxic contaminant goal and research outcome:

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: Continually 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 best management practices might provide multiple benefits of reducing nutrient and sediment pollution as well as toxic contaminants in waterways.

Baseline and Current Condition: The TCW originally worked with stakeholders in 2015 to identify the priority issues to be addressed for this strategy. These issues have been in this version of the strategy as part of the CBP review process, with 2 of the issues being substantially modified (issues 3 and 4):

1. Supply information to make fish and shellfish safer for human consumption.
2. Understand the influence of contaminants degrading the health, and contributing to mortality, of fish and wildlife.
3. Document the sources, occurrence, and transport of contaminants in different landscape settings.
4. Identify and prioritize options for mitigation to inform policy and prevention strategies.
5. Gather information on issues of emerging concern.

Much of the baseline information for these issues came from the report “Extent and Severity of Toxic Contaminants in the Chesapeake Bay Watershed” (Chesapeake Bay Program, 2013), which provided a summary of 10 contaminant groups within the Bay watershed. A qualitative assessment of the baseline understanding for the sources, occurrence, and effects for these contaminant groups was prepared by the TCW for the original strategy (summarized in figure 1). The contaminant groups with the greatest uncertainty are the emphasis of the research efforts.

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
PCBs				
Dioxins/Furans				
PAHs				
Petroleum Hydrocarbons				
Pesticides				
Bio. Hormones				
Pharms.				
HPCP				
PBDEs				
Metals				
Mixtures				

Uncertainty
Small
Mid
Large

Priorities for an agenda to increase certainty?

Figure 1: Level of uncertainty for ten contaminant groups about the occurrence, concentrations, sources, and effects on fish and wildlife.

Issue: Supply information to make fish and shellfish safer for human consumption

Polychlorinated biphenyls (PCBs) and mercury are the primary causes of fish consumption advisories that have been issued in the Chesapeake Bay and its watershed. PCBs are suspected human carcinogens whereas methyl mercury (the dominant and toxic form of mercury that accumulates in fish) is known to cause impaired neurological development. In addition, both of these pollutants have adverse ecological impacts. The sources of these pollutants to fish and wildlife can be a combination of exposure to legacy deposits in sediments, ongoing inputs to the watershed from secondary sources (e.g., PCB contaminated terrestrial sites, previously contaminated stormwater pipes), and ongoing releases (e.g., wastewater and stormwater releases and atmospheric deposition, especially for mercury). Given these concerns, PCBs were the focus on the initial management strategy for Toxic Contaminant Policy and Prevention. The PCB strategy has a specific management approach to provide science to inform reduction of PCBs and that strategy and work plan should be consulted for more detailed information.

For mercury reductions in fish and shellfish, the jurisdictions in the Bay watershed are depending on national air emission controls and less use of coal for energy production, which should result in less mercury being deposited in the Chesapeake watershed. For the revised management strategy, efforts will be made to improve the understanding of baseline conditions by compiling information on the extent of mercury impairments across the watershed. The jurisdictions will work through the TCW to inventory data and assess if information exists to document changes in mercury in response

to air controls. The results will be used to help jurisdictions consider if additional efforts are needed to reduce the impacts of mercury.

There is a much broader set of issues related to the effects of toxic contaminants on human health. However, these issues are beyond the scope of the Chesapeake Bay Watershed Agreement so they are not included in this Toxic Contaminants Research Management Strategy. Many of the human health issues, such as occupational exposure or exposure in residential setting (i.e., lead paint), are being addressed by other government agencies and research organizations and may be incorporated in future efforts if needed to meet the outcome.

<u>Issue: Understand the influence of contaminants degrading the health, and contributing to mortality, of fish and wildlife</u>

There are numerous indications of reduced general and reproductive health of fish populations throughout the watershed. Research findings to date strongly suggest the influence of toxic contaminants. Observed conditions include widespread occurrence of intersex and other gonadal abnormalities, reduced reproductive success of semi-anadromous fishes, occurrence of skin and liver tumors, skin lesions, high parasite loads and opportunistic infectious disease. The impact of endocrine-disrupting chemicals (EDCs) on reproductive systems of fish and wildlife has been documented by the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (FWS), and the National Oceanographic and Atmospheric Administration (NOAA). Chemical contaminants, including legacy and chemicals of emerging concern, particularly EDCs have had effects on fish (reproductive systems in several species) and selected waterbirds in the Bay ecosystem.

Toxic contaminants may also contribute to fish and wildlife kills, in addition to degrading health, in the Bay and its watershed. Kills are generally defined as large numbers of fish or wildlife dying within a relatively short period of time. Some of the known fish and wildlife kills and their causes include:

- Acute kills of fish and wildlife due to hydrocarbon spills. Fish and wildlife species have been killed by oil spills such as the Colonial Pipeline Spill in a Potomac River tributary and the Chalk Point Oil Spill on the Patuxent River. Localized kills have been linked to a sequence of events resulting in algal blooms and die-off of the algae depleting available oxygen. Algal blooms of toxin-producing species have occurred in several years at Poplar Island, resulting in the deaths of hundreds of waterbirds. These are linked to Microcystis and possibly with avian botulism.
- Fish kills in the Chesapeake Bay watershed have also been associated with one or more pathogens and include the kills of menhaden with ulcerative mycosis in estuarine tributaries. In the case of the menhaden lesions and kills, one pathogen *Aphanomyces invadans,* was consistently observed in the ulcerative lesions.

Fish kills have been associated with multiple potential causes, such as pathogens, parasites, disease, and contaminants. Kills of adult bass and sunfish in the Potomac basin and young-of-the-year smallmouth bass in the Susquehanna basin have occurred in multiple years and multiple sub-watersheds. These observations together with the concurrent observations of intersex and other indicators of contaminant exposure suggest multiple causes contribute to fish mortality and poor heath. Findings also suggest that toxic contaminants can influence immunosuppression, and making the fish more vulnerable to other factors.

Studies since 2015 continue suggest that multiple factors affect fish health and mortality. For example, recent studies (2017-18) in the Susquehanna basin identified disease as an important factor leading to fish health problems and mortality. These studies reveal the difficulties in identifying individual stressors or factors, and relating individual contaminants, to causes of degraded fish health and/or morality.

Finally, the appearance of estrogenic hormones, UV filters, and antibiotics in the environment has drawn increasing attention due to potential impacts on human and ecological health. Potential sources of estrogenic hormones and antibiotics include wastewater treatment effluents and animal feeding operations. New studies by UMBC in the Chesapeake Bay mainstem are examining the occurrence of these toxic compounds in the eastern oyster (Crassostrea virginica), and hooked mussel (Ischadium recurvum). Results highlight the ubiquitous bioaccumulation of CECs in aquatic and marine invertebrates.

The role of contaminants in the health of numerous wildlife species, including birds, amphibians and reptiles is not as well documented. Results from the 2013 federal report (Chesapeake Bay Program, 2013) reveal the indications of responses to contaminant exposure have also been found among wildlife in the Chesapeake Bay watershed, primarily wild birds. In a few locations, eggshell thinning associated with *p,p'*-DDE is apparent, and reproduction may be impaired. In some cases, organochlorine pesticides are found in eggs of predatory birds at concentrations associated with embryo lethality. Several studies are cited in which PCB concentrations in addled bald eagle eggs may have been high enough to contribute to the failure to hatch. Detectable concentrations of PBDEs have been found in eggs of predatory birds that approach the lowest-observed-adverse-effect level for pipping and hatching success. A summary of wildlife issues and toxic contaminants (conducted in 2016) found there was still very limited information to assess effects on wildlife.

<u>Issue: Document the sources, occurrence, and transport of contaminants in different landscape settings</u>

The extent, severity, and sources of ten groups of toxic contaminants in the Bay watershed had been previously summarized from existing information (Chesapeake Bay Program, 2013) and are listed in Table 1. Contaminant groups, including PCBs, mercury, polycyclic aromatic hydrocarbons (PAHs), and some pesticides have widespread extent, while the remainder of the groups had local extent. The findings for severity were based on impairments developed by watershed jurisdictions, which rely on the monitoring of select contaminants in water, sediment and fish tissue. Impairments included human health concerns (e.g., fish consumption advisors), or potential harm to aquatic organisms. This issue will evolve to focus more on specific landscape settings that are the primary sources of contaminants: urban areas, agricultural lands, and WWTPs. There will be emphasis on defining the co-occurrence with nutrients and sediment to help take advantage of CBP efforts to improve water quality.

Table 1: Extent and Severity of Contaminant Groups (from Chesapeake Bay Program, 2013)	
Contaminant Group	**Extent, Severity, and Sources**
Polychlorinated biphenyls (PCBs)	PCBs have widespread extent and severity. The severity was based on risk to human health through consumption of contaminated fish with impairments identified in all of the watershed jurisdictions. Some primary sources are contaminated soils, leaks from transformers, and atmospheric deposition.
Mercury	Mercury had both widespread extent and severity. The severity was based on risk to human health through consumption of contaminated fish. The primary source is air emissions from coal-fired power plants.
Polycyclic aromatic hydrocarbons (PAHs)	Widespread extent throughout the Bay watershed. The severity was localized based on impairments for risk to aquatic organisms in a limited number of areas in the watershed. The primary sources are contaminated soils, road sealants, atmospheric deposition, and combustion.
Pesticides	Widespread extent of selected herbicides (primarily atrazine, simazine, metochlor, and their degradation products) and localized extent for some chlorinated insecticides (aldrin, chlordane, dieldrin, DDT/DDE, heptachlor epoxide, mirex). The chlorinated insecticides have localized severity based on risk to aquatic organisms. For many pesticides that had widespread occurrence, water-quality standards were not available to determine impairments. Research shows sublethal effects for some compounds at environmentally relevant concentrations. Primary sources are applications on agricultural and urban lands and legacy residue in soils.
Petroleum hydrocarbons	Localized extent and severity (to aquatic organisms) in a limited number of areas in the watershed.
Dioxins and Furans	Localized extent and severity (to aquatic organisms) in a limited number of areas in the watershed. The primary sources are spills, contaminated soils, and atmospheric deposition.
Metals and Metalloids	Localized extent and severity (to aquatic organisms) of some metals (aluminum, chromium, iron, lead, manganese, zinc) in a limited number of areas in the watershed. The primary sources are spills, industrial processes, and atmospheric deposition.
Pharmaceuticals, Household and Personal Care Products, Flame Retardants, Biogenic Hormones	Information was not adequate to determine extent or severity. However, their use in the watershed suggests widespread extent is possible. Severity was not accessed but research shows sublethal effects to selected aquatic organisms for some compounds at environmentally relevant concentrations. Range of sources from wastewater treatment and septic tanks to animal feeding operations. Biogenic hormones assessment was focused on naturally occurring compounds from human or animals.

Issue: Identify and prioritize options for mitigation to inform policy and prevention

This management approach will evolve to identify and prioritize options for mitigation instead of developing approaches relative risk of different contaminant groups. This will provide a more

streamlined approach to develop options for reducing the impacts of contaminants in settings where they are most prevalent and take advantage of nutrient and sediment reductions efforts.

Issue: Gather information on issues of emerging concern

Issues of emerging concerns identified in the original strategy were are (1) contaminant toxicity to pollinators (including neonicotinoids), (2) microplastics, and (3) unconventional oil and gas drilling (known as "fracking"). Some information was gathered on these topics but not enough to understand background conditions across the entire watershed.

New issues suggested for the revised strategy include: (1) harmful algal blooms and their associated toxins; and (2) the potential effects of poly- and perflouroalkyls (PFASs), and reducing the effects of road salts.

Cyanobacterial harmful algal blooms (cyanoHABs) are increasingly a global concern. CyanoHABs can threaten human and aquatic ecosystem health; they can cause major economic damage.
The toxins produced by some species of cyanobacteria (called cyanotoxins) cause acute and chronic illnesses in humans. Harmful algal blooms can adversely affect aquatic ecosystem health, both directly through the presence of these toxins and indirectly through the low dissolved oxygen concentrations and changes in aquatic food webs caused by an overabundance of cyanobacteria. USGS scientists are leading a diverse range of studies to address cyanoHAB issues in water bodies throughout the United States, using a combination of traditional methods and emerging technologies in collaboration with numerous partners. However, despite advances in scientific understanding of cyanobacteria and associated compounds, many questions remain unanswered about the occurrence, the environmental triggers for toxicity, and the ability to predict the timing and toxicity of cyanoHABs. (https://www.usgs.gov/news/science-harmful-algae-blooms).

PFASs have been manufactured and used in a variety of industries since the 1940s. United States since the 1940s. They are no longer produced or in use; however, they are persistent in the environment and have been shown to have adverse health effects. Recently, New Jersey issued fish consumption guidelines for PFAS compounds (https://www.nj.gov/dep/dsr/). Another primary source of human exposure is drinking water. Little is known about PFAS in Chesapeake Bay, but due to its wide use in many consumer (food packaging, non-stick cookware) as well as industrial products (fire fighting foams), there is the possibility for widespread extent in surface water.

Road salts, when applied in large amounts to reduce ice and snow, effect the quality of streams. The State of MD is considering a TMDL for chloride to help reduce the impacts of road salts on stream health.

II. Participating Partners

The following partners participated in the revision of this strategy. A workplan with more details on actions for each partner during for 2018-19 has also been prepared.

Chesapeake Bay Watershed Agreement Signatories

- Maryland Department of the Environment
- Maryland Department of Natural Resources
- Virginia Department of Environmental Quality

- DC Department of the Environment
- Pennsylvania Department of Environmental Protection
- Delaware Department of Natural Resources and Environmental Control
- New York Department of Environmental Conservation
- West Virginia Department of Environmental Protection
- Chesapeake Bay Commission (CBC)
- U.S. Environmental Protection Agency
- U.S. Geological Survey
- U.S. Fish and Wildlife Service
- National Oceanic and Atmospheric Administration

Other Key Participants

- Non-Governmental Organizations
  - Bluewater Baltimore
  - Metropolitan Washington Council of Governments
  - MD Pesticide Network
- Private sector organizations
- University of Maryland, Baltimore County
- Virginia Polytechnic Institute and State University
- Virginia Institute of Marine Science
- CBP Local Government Advisory Committee
- CBP Water Quality Goal Implementation Team Workgroups

Local Engagement

Most of the actions to plan and complete the actual research are expected to be the responsibility of federal, state and academic entities. Local governments and NGOs have been helpful in identifying priorities within the research strategy, including NGOs from Baltimore Harbor, the Elizabeth River, and the Anacostia River. Increasing the awareness of the impacts of toxic contaminants, especially safe consumption of fish and shellfish, will be carried out with local governments and organizations and will be targeted towards areas with diverse and underrepresented populations in the bay watershed.

III. Factors Influencing

The revised factors for the strategy include:

Differing standards for fish consumption advisories

The jurisdictions have different assumptions about human exposure through fish consumption, which can limit comparability across the watershed. There are also resource constraints to collect and analyze fish and associated samples every year to assess attainment of standards.

Multiple factors affecting the health and mortality of fish and wildlife

Studies suggest there are multiple contaminants and additional factors are causing the degradation (and mortality) of fish and wildlife. Therefore, trying to identify specific causes is extremely difficult and complicates developing management options.

Lack of data on the occurrence and trends of contaminants

There is no watershed-wide monitoring program on the condition of fish and wildlife that is integrated with water and sediment sampling. There is a lack of consistent information (both spatial and temporal) on the occurrence and concentrations of toxic contaminants. Some of this is due to the high cost of generating new data on toxic contaminants. Additionally, there are few laboratories that have the capabilities to conduct analysis for all the contaminant groups. This limits the ability to understand the extent of contaminants in the watershed and their relation to fish and wildlife.

Limited information of the effects practices to reduce contaminants, and relation to nutrients and sediment

More information on the effectiveness of practices to reduce selected contaminants will be needed to take advantage of CBP water-quality models and tools, which are currently focused on nutrients and sediment.

Emerging issues

There is limited knowledge and capacity to assess importance and implications of emerging issues.

Synthesis: This is a new factor which recognizes the findings from technical articles and reports need to be summarized and communicated to be used effectively by resource managers.

IV. Current Efforts and Gaps

There are ongoing efforts, by multiple organizations in the Bay watershed, to assess toxic contaminants and their effects on fish and wildlife. The types of studies and monitoring include:

- Monitoring to assess water-quality impairments and issue fish consumption advisories in state waters.
- Documenting the extent of degraded fish conditions and wildlife conditions and relation to toxic contaminants and other factors (such as disease). Specific examples include monitoring the prevalence of liver tumors in fish and the linkage with sediment contamination.
- Monitoring and assessment for occurrence and concentrations of selected contaminant groups (such as pesticides) and their relation to different sources.
- Research on effectiveness of management practices and mitigation techniques to reduce contaminants.

A brief description of the current efforts and associated research gaps for the five issues in this strategy are discussed. Efforts to address the research gaps are presented in the management approaches (next section).

<u>Issue: Supply information to make fish and shellfish safe for human consumption</u>

- ***Current Efforts****:* All states and DC, in cooperation with USEPA, have existing monitoring programs to identify impairments in water bodies and set fish consumption advisories In most jurisdictions, PCBs and mercury are the primary causing fish consumption advisories.
- ***Research Gaps for PCBs****:* The policy and prevention strategy has a detailed discussion on the research gaps for PCBs, which focuses on sources, and BMP effectiveness.

- ***Research gaps for Mercury***:

For mercury reductions, the jurisdictions in the Bay watershed are depending on national air emission controls and less use of coal for energy production. However, data are lacking to determine the extent of mercury impairments throughout the watershed, and if mercury is decreasing in the environment from these controls. Additionally, there is limited information on the amount of methyl-mercury in the Chesapeake watershed and its pathways to cause fish consumption advisories.

Issue: Understand the influence of contaminants degrading the health, and contributing to mortality, of fish and wildlife

- ***Current efforts****:* Research is ongoing between jurisdictions, federal, and academic partners to better understand the influence of toxic contaminants on the health of fish and wildlife as well as confounding factors that may make them more susceptible to these contaminants. In the Potomac and Susquehanna basins, studies are also addressing the complex interactions of chemical, pathogens and parasites, and other factors contributing to fish mortalities. Some selected studies are described below.

The USGS is completing a five-year study in 2019 to better understand the effects of known EDCs and chemicals of emerging concern on fish and wildlife within the Chesapeake watershed. The study includes assessing adverse effects in wild fishes, experimental exposures of key species to mixtures, based on chemical concentrations measured in affected areas, assessing the role of mercury as an endocrine disruptor, monitoring amphibian populations of adverse effects, as well as exploring the potential for EDCs to be affecting avian and reptile populations.

The National Aquatic Resource Survey (NARS)/National Coastal Condition Assessment (NCCA) evaluates a selection of metals, PCB congeners, PAHs, and pesticides in surficial sediment and in fish tissues on a five-year recurrent schedule. A number of sites in the national survey routinely fall within the tidal portions of the Chesapeake Bay watershed. The Virginia DEQ Estuarine Probabilistic Monitoring Program routinely analyzes the same group of sediment analytes at approximately 30 sites per year within the tidal portion of the CB watershed. Sediment toxicity and benthic community health (CBP B-IBI) are concurrently evaluated at each site. Efforts are currently underway to recalibrate the CBP B-IBI using sediment chemistry, sediment toxicity, and benthic community data from probabilistic monitoring sites.

Pennsylvania initiated a large-scale study of the Susquehanna River drainage in response to the decline of the smallmouth bass population. Results suggest disease in a major factor contributing to the population decline. Additional studies by USGS suggest other factors, including toxic contaminants and water-quality variables also impact the overall health of several aquatic communities.

State agencies usually have the lead to respond to fish and wildlife kills and determine if the likely cause is a spill or accidental release of petroleum, toxic contaminants, or low dissolved oxygen conditions. Additionally, the NOAA Office of Response and Restoration assesses fish kills due to chemical spills in coordination with the US Coast Guard and state agencies.

- ***Research gaps****:* Research is still needed to determine the primary contaminants (and mixtures) adversely affecting general, as well as reproductive, health of fish and wildlife populations within the watershed. Studies conducted over the past several years have had difficulty defining which contaminants (and mixtures), and factors contribute to 1) causing the greatest degree degradation of the health and reproductive systems of fish and wildlife, (2) compromising the immune systems of fish and making them more susceptible to other environmental stresses, such as pathogens, parasites; and the effects of hypoxia; 3) prevalence of for tumors; and 4) in embryo and larval survival.

Some of the more specific research gaps suggested for fishery issues in the revised strategy include:

1. **Effects of contaminants on fish reproduction.** The role of contaminants and other factors on the reproduction of yellow perch has been a need identified by MD. Lack of reproductive success of yellow perch and other anadromous fishes has been documented in certain urban tributaries. A clear relationship between percentage of impervious surface and declining recruitment of yellow perch and river herring has been demonstrated. In yellow perch, effects on egg quality (abnormal yolk, thin chorions) have been observed. A better understanding of the multiple stressors including contaminants, hypoxia, sediment and nutrient loading and changes in salinity is necessary to prevent further declines.

2. **The causes of fish tumors.** Several states and DOI want a better understanding of the causes of tumors on several species, including important recreational species. A high prevalence of skin and liver tumors in brown bullhead catfish and liver tumors in mummichogs has been documented. While there is evidence for the role of PAHs in liver carcinogenesis, other factors acting as both promoters and initiators are not well studied. Research is needed on risk factors associated with these tumors

3. **The relation between contaminants and fish disease.** The complex interactions between contaminants and infectious disease need to be understood. While contaminants can adversely affect the ability of an organism to resist infectious diseases and parasites, the presence of these biological agents can also affect the ability of an organism to metabolize and otherwise deal with exposure to chemical contaminants.

<u>Issue: Document the sources, occurrence, and transport of contaminants in different landscape settings.</u>

Better understanding sources, occurrence and transport of contaminants in different landscape settings helps (1) assess potential effects on fish and other organism (previous issues), and (2) formulate management options (next issue). We have evolved this issue to address the important link between sources, occurrence, and transport of contaminants in different landscape settings, (figure 2), and their relation to nutrients and sediment.

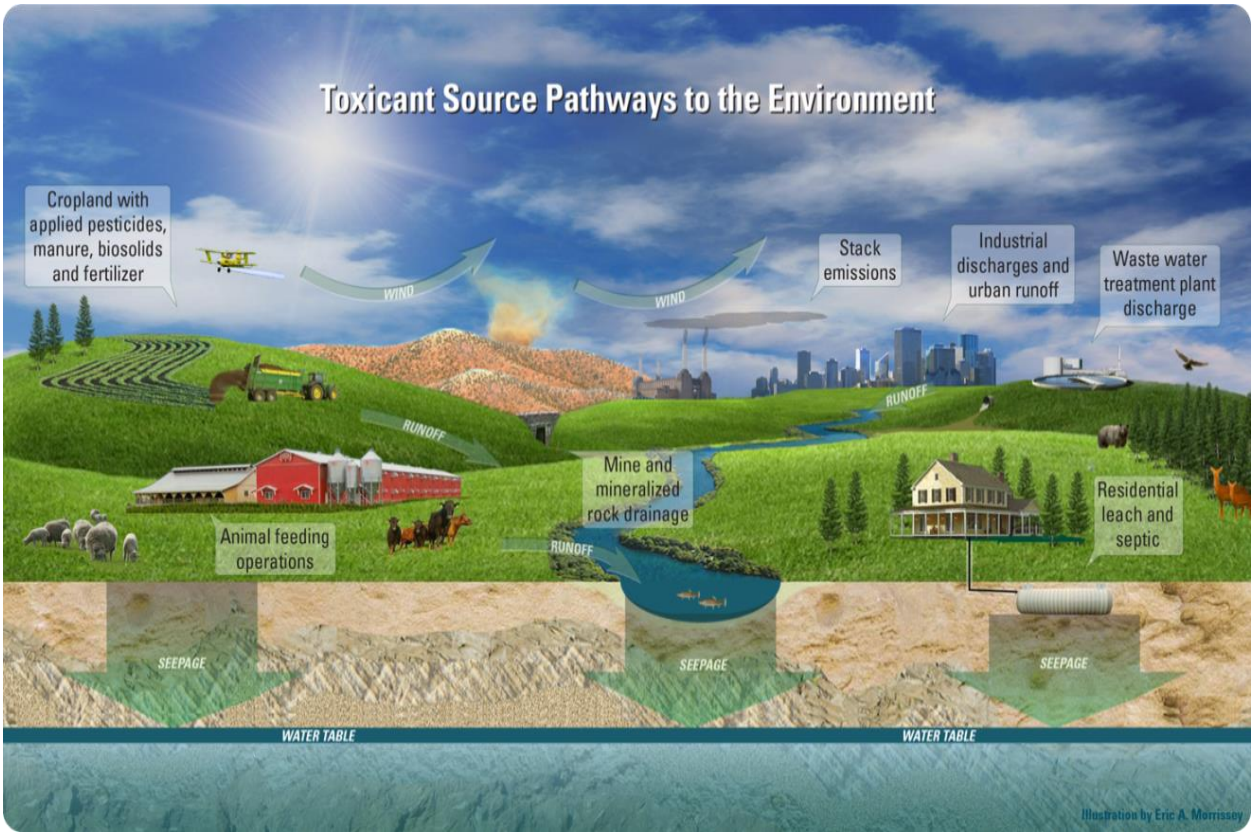


Figure 2: Conceptual diagram of sources, transport pathways of contaminants (from K. Smalling)

Current Efforts: All the states and several federal agencies monitor different types of contaminants but only in selected areas and varying collection frequencies. There have been efforts to summarize the occurrence of selected contaminants in agricultural and urban areas.

Research gaps: There is no watershed-wide monitoring program on the condition of fish and wildlife that is integrated with water and sediment sampling. Lack of consistent information (both spatial and temporal) on the occurrence and concentrations of toxic contaminants. Some of this is due to the high cost of generating new data on toxic contaminants. Additionally, there are few laboratories that have the capabilities to conduct analysis for all the contaminant groups.

Issue: Identify and prioritize options for mitigation to inform policy and prevention
The TCW is proposing a new scope for this issue based on what is learned from the previous issues on sources, occurrence and transport. The finding will be used to help focus identify and prioritize mitigation options for contaminants from specific landscape settings. For example, in agricultural areas, focus would likely be on manure and row crops. In urban settings, addressing both WWTPs and storm water runoff will be important.

- ***Current Efforts:*** There are efforts to assess mitigation potential for a limited number of contaminants.

- ***Research gaps:*** the primary research gaps are include more specific information on effectives of specific BMPS to reduce selected contaminants, research on mitigation

approaches, and enhancing nutrient and sediment tools to assess potential loading reductions for contaminants.

Issue: Gather information on issues of emerging concern

- ***Current Efforts****:* There are some ongoing national and regional studies on microplastics and UOGs.
- ***Research needs***: There is very little knowledge within the Bay watershed on (1) contaminant toxicity to pollinators (including Neonicotinoid pesticides), and (2) microplastics, and (3) chemicals from UOG activities and their effects on fish and wildlife. New research items have been suggested for HABs, flame retardants, and road salts.

Actions, Tools and Support to Empower Local Government and Others

- ***Current Efforts****:* The research workgroup has reached out to local organizations within some of the areas of most concern including the Baltimore Harbor and Anacostia watershed. In both the Susquehanna and Shenandoah watersheds, the USGS has been interacting with the respective RiverKeeper organizations.

- ***Research Gaps****:* There has been limited activity to engage additional local groups about the issues being addressed by the research strategy. Also need to assess where fish consumption advisories are being issued to determine the extent of their occurrence in diverse communities.

V. Management Approaches

The Partnership will work together to carry out the following approaches to make progress toward the Toxic Contaminants research outcome. These approaches seek to address the factors affecting our ability to meet the goal and the gaps identified above.

The management approach addresses each of the major issues identified at the beginning of the strategy. The management approach builds from existing research and monitoring efforts to address the research gaps and factors influencing our ability to meet the toxic contaminant goal. Since resources are limited, some guiding principles for the management approach are to:

- Focus studies on areas where fish and wildlife have been degraded and/or there are human health concerns.
- Better understand and identify the multiple stressors and mixtures of contaminant groups contributing to degraded fish and wildlife.
- Improve the understanding between sources of these contaminants (and mixtures), their pathways to the environment, and exposures to receptor organisms.

Approach: Supply information to make fish and shellfish safe for human consumption

This approach will help address the factor "**Differing standards for fish consumption advisories"** The current toxic contaminants prevention and policy management strategy is focused on reducing the impacts of PCBs. Additional information will be generated for PCBs sources and transport pathways so the policy and prevention strategy can be improved in 2018-19. These research efforts are reflected below and additional science support activities are in the Policy and Prevention strategy. The science approaches to address the research gaps for PCBs includes:

- 1. **Identify sources** This would include all the source tracking efforts; and could include the modeling since that is an one use of the modeling efforts.
- 2. **BMP effectiveness T**his would be your mitigation topic and either title works for me. We could include work on reducing PCBs and how to put into CAST)
- 3. **Status and change of environment conditions**. This would address lab and field methods so they are comparable across the watershed; Item would also address "measuring progress item of the P&P strategy" to document if PCB concentrations are being reduced from the BMP efforts.

Mercury: For the revised Management Strategy, efforts will be made to improve the understanding of baseline conditions by compiling information on the extent of mercury impairments across the watershed. The jurisdictions will work through the TCW to inventory data and assess if information exists to document changes in mercury in response to air controls. The results will be used to help jurisdictions consider if additional efforts are needed to reduce the impacts of mercury.

Issue: Understand the influence of contaminants in degrading the health, and contributing to mortality, of fish and wildlife

The research efforts will provide a better understanding of the factors affecting health of fish, shellfish, and wildlife, with a focus on high value species (for commercial and recreational fishing, and rare and endangered species). The states in the watershed (as well as DC) have active projects, many in cooperation with USGS, FWS and academic partners, attempting to discern causes of declining fish health, and fish mortality, in their respective drainage areas of the Bay watershed. These efforts will help address the factor "**Multiple factors affecting the health and mortality of fish and wildlife"**

Several efforts will help improve understanding over the next several years. The USGS will complete its Chesapeake EDC study and presenting results on the sources, pathways and effects of these compounds on fish in selected agricultural areas. As the USGS work is completed they will be evolving to focus more on urban areas through several national project efforts. The USGS will be partnering with several states to identifying the factors (contributing to the proliferation of parasite and opportunistic pathogens associated with mortality of selected species in the watershed. The FWS and USGS, will work with partners to address the factors affecting reproduction of yellow perch and cause of tumors in different areas of the watershed. UMBC will be continuing research on the occurrence of selected toxic compounds in oysters throughout MD waters. To assess the effects of toxic contaminants on wildlife, USGS will publish results from a data synthesis.

Approach: Document the sources, occurrence, and transport of contaminants in different landscape settings.

This management approach will address the factor "**Lack of data on the occurrence and trends of contaminants"** Identifying the settings where the sources of the contaminants are expected to have the maximum impact on fish, amphibian, and other biological resources will help focus this approach. . Sources include agricultural, wastewater, urban, and suburban lands with more information needed on potential relation to animal manure and agricultural runoff, aging sewer infrastructure, septic systems, urban runoff, and biosolids. We will also look at the co-occurrence of contaminants with nutrients and sediment to find opportunities for mitigation options (next approach The three primary work activities will be:

- Better understand the sources, occurrence, and transport of toxic contaminants in multiple landscape settings
- Address the relation of toxic contaminants to nutrients and sediments
- Improve information on loading rates of contaminants in different landuse settings.

Approach: identity and prioritize options for mitigation to inform policy and prevention

The TCW needs to identify and prioritize mitigation options to help inform policy and prevention strategies. This approach will address the factor for "**Limited information of the effects practices to reduce contaminants, and relation to nutrients and sediment"**

Both PCBs and mercury have widespread extent and severity and also cause fish consumption advisories, so they are being addressed first for mitigation options.

For other contaminants and their mixture, the TCW will use the information from previous approach on landscape settings to identify and prioritize mitigation options. Work activities will include:

- Studies of mitigating contaminants in different landscape settings
- Determine the efficiencies of some management practices to reduce selected contaminants
- Explore the use of existing nutrient and sediment tools (such as CAST and watershed model) to address selected contaminants.
- Interact with WQ GIT teams on opportunities to achieve co-benefits between nutrient and sediment practice and contaminant reductions.

Information generated from the research strategy, will be continuously shared with the TCW, and key source WG of the WQ GIT (WWTPs, storm water, and agricultural) so they can consider options for mitigation impacts of toxic contaminants.

Approach: Gather information on issues of emerging concern

The TCW will keep abreast of efforts to understand an original topic of microplastics and consider three new issues:(1) harmful algal blooms and their associated toxins; and (2) the potential effects of poly- and perflouroalkyls (PFASs), and reducing the effects of road salts. The TCW will reach out to investigators of on-going studies to increase our understanding and implications for the Chesapeake ecosystem.

Approaches Targeted to Local Participation

The research team will work with local organizations to inform them of ongoing studies and discuss closer interaction. Potential interactions include having the researchers work with local governments and non-profits to identify target locations in watersheds to demonstrate tracking technologies, resulting in actual source-identification and elimination outcomes in targeted jurisdictions, and, at the same time, help to increase technical capacity of local participants. EJ SCREEN will also be used to target areas in the watershed with diverse populations where fish consumption advisories are being issued.

Collaborating with other Management Strategies

There is potential cross-collaboration working with WQ Goal Team (to reduce nutrients and sediment); Habitats (improve stream health), and Fisheries (making fish and shellfish safer to eat).

VI. Monitoring Progress

Two types of monitoring are being considered: (1) programmatic and (2) environmental. Programmatic monitoring will focus on completion of planned activities for actions in the research strategy and biannual workplan. Environmental monitoring provides several types of information (1) to improve of knowledge of baseline conditions for occurrence, concentrations, sources and effects for the highest priority pollutants and (2) supports the policy and prevention outcome to help assess effects of management practices. Initial ideas for monitoring to improve information of environmental conditions for 5 major issues include:

- ***Human consumption***: Update the status of fish health consumption advisories and impairments in the Bay watershed due to PCBs and mercury. Monitoring of levels of PCBs and mercury at sentinel sites to assess if reduction activities are having desired benefit.

- ***Fish and wildlife health***: Develop indicators for fish and wildlife health to better characterize their extent in the watershed. Possibilities include indictors of (1) intersex conditions in fish, and/or (2) presence of tumors in fish.

- ***Occurrence of contaminants***: Summarize the monitoring results of the selected compounds listed existing efforts to better document their extent.

- ***Management approaches***: Have selected contaminants put into CBP tools so stakeholders can assess options to reduce contaminants, nutrients, and sediment.

- ***Issues of emerging concern***: Summarize information on issues of emerging concern to assess if their need to be in future research strategies.

VII. Assessing Progress

Assessing programmatic progress (making sure planned activities are completed) will be at least annual so that adjustments to the biennial workplan can be made to accommodate changing circumstances and availability of resources. Formal review of programmatic progress will be completed through the update of the biennial workplan.

Assessment of environmental conditions and change will be done less frequently (every 2 to 5 years) depending on availability of contaminant monitoring results. We will utilize the biannual reporting for impaired waters (305b) done by each state and DC to assess conditions for selected contaminants that monitored for these efforts. Monitoring for additional contaminants will be done less frequently due to efforts needed to collect, compile, and analyze information. The planning, completion and publishing of research is usually a multi-year process which affects the advancement in gaining more knowledge to reduce uncertainty.

VIII. Adaptively Manage

The Toxic Contaminants Workgroup will assess the management implications from the research findings and decide on updates (that are required every two years) needed to policy and prevention strategy to address contaminants beyond PCBs. There will be interchange between the research and policy and prevention teams of the TCW to discuss evolution of research issues every two years to support management needs.

IX. Biennial Workplan

The Biennial workplans for this strategy contains actions for 2018-19.