Technical Report on Toxic Contaminants in the Chesapeake Bay and its Watershed: Extent and Severity of Occurrence and Potential Biological Effects

Chapters 3 and 4: The Fish and Wildlife Chapters

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U.S. EPA, Chesapeake Bay Program. Annapolis, MD Feb. 28, 2013
Responses of Fish to Cumulative and Interacting Stressors

- Fish kills/ intersex/ endocrine disruption
- Reproductive impairment in yellow perch
- Tumors in bottom-dwelling fish
Fish Health Issues

- Adult bass and other fish species in the Potomac and James River drainages – spring
  - Major kills in the South Brach Potomac 2002-2033
  - Major kills in the South Fork and North Fork Shenandoah 2004-2005
  - Lower mortality rate in subsequent years
  - Major kill in the Monocacy 2009

- Young of the year smallmouth bass in the Susquehanna River drainage since 2005 - summer
Overview of Intersex Findings

- Intersex is widely distributed in bass (smallmouth, largemouth) in the Potomac and Susquehanna drainages
- Prevalence and severity at many sites is greater than we see at most other sites nationally
- Species differences (metabolic, life styles)
- Seasonal differences in intersex and Vtg
- Intersex bass had significantly less sperm, less motile
- Prevalence of intersex was not higher downstream of WWTP
## Upstream/Downstream of WWTP

<table>
<thead>
<tr>
<th>Site</th>
<th>No. Males</th>
<th>Intersex Prevalence</th>
<th>Intersex Severity</th>
<th>% males w Vtg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susquehanna – U</td>
<td>14</td>
<td>93%</td>
<td>1.4</td>
<td>21%</td>
</tr>
<tr>
<td>Susquehanna – D</td>
<td>9</td>
<td>89%</td>
<td>1.7</td>
<td>11%</td>
</tr>
<tr>
<td>Swatara – U</td>
<td>4</td>
<td>75%</td>
<td>0.6</td>
<td>0%</td>
</tr>
<tr>
<td>Swatara – M</td>
<td>6</td>
<td>67%</td>
<td>1.0</td>
<td>50%</td>
</tr>
<tr>
<td>Swatara – D</td>
<td>6</td>
<td>100%</td>
<td>2.0</td>
<td>0%</td>
</tr>
<tr>
<td>Monocacy – U</td>
<td>11</td>
<td>82%</td>
<td>1.2</td>
<td>45%</td>
</tr>
<tr>
<td>Monocacy – D</td>
<td>7</td>
<td>100%</td>
<td>1.8</td>
<td>33%</td>
</tr>
<tr>
<td>Conococheague – U</td>
<td>10</td>
<td>100%</td>
<td>2.2</td>
<td>60%</td>
</tr>
<tr>
<td>Conococheague – D</td>
<td>10</td>
<td>90%</td>
<td>1.8</td>
<td>90%</td>
</tr>
</tbody>
</table>
Intersex Prevalence
Smallmouth Bass

Prevalence of intersex
PA1 PA4 PA3 PA7 PA8 PA11 PA9 PA12 PA13 PA14 PA15 PA16
Sites

Prevalence of intersex

Delaware

Susquehanna

Ohio
## Intersex and Land-use

<table>
<thead>
<tr>
<th>Landuse Characteristics</th>
<th>Intersex Prevalence</th>
<th>Intersex Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r²</td>
<td>p</td>
</tr>
<tr>
<td>Human population</td>
<td>0.39</td>
<td>0.10</td>
</tr>
<tr>
<td># WWTP</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>WWTP flow</td>
<td>0.32</td>
<td>0.15</td>
</tr>
<tr>
<td>Percent agriculture</td>
<td>0.63</td>
<td>0.02</td>
</tr>
<tr>
<td># Animal feeding operations</td>
<td>0.28</td>
<td>0.17</td>
</tr>
<tr>
<td>Total animal numbers</td>
<td>0.27</td>
<td>0.18</td>
</tr>
<tr>
<td>Animal density</td>
<td>0.49</td>
<td>0.05</td>
</tr>
<tr>
<td>Poultry Houses</td>
<td>0.27</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Reproductive health of yellow perch in selected tributaries of the Chesapeake Bay

• **Problem**: poor reproduction in western shore tributaries, few viable larvae

• **Approach**: 3-year sampling of males and females during spawning runs: compare Severn, South, Mattawoman, Allen’s Fresh, Choptank
• **Key Findings**

  – Severn River: no eggs fully developed—all years
  – Severn and South Rivers: increased prevalence of egg envelope and yolk abnormalities
  – Mattawoman Creek: egg envelope abnormalities in one of three years
  – Relationship with suburban development

Ovary abnormalities

Testis abnormalities
Unanswered questions

• What causes these abnormalities?
  – Chemical sampling conducted in 2012 with followup in 2013
  – What is the relationship between urbanization and yellow perch population declines?
  – What is the role of hypoxia?
  – How will climate change affect yellow perch?
Fish Tumors as an Environmental Indicator

Squamous cell carcinoma: Brown bullhead from the South River
Liver tumors:  
Clear linkage with sediment PAHs

Cholangiocarcinoma

Hepatocellular carcinoma

John Harshbarger, George Washington University
Environmental Indicator: monitor habitat quality and response to cleanups

- Elizabeth River Project: mummichog liver tumors monitor success of sediment remediation
- Anacostia River (in progress): brown bullhead liver tumors vs. sediment chemistry concentrations
- Great Lakes/Puget Sound examples

Contaminant Exposure and Responses in Wildlife

Pesticides

- Exposure and associated adverse effects of organochlorine pesticides, and the most hazardous organophosphorus and carbamate pesticides, have declined in recent years.

- Toxicological effects of chronic low-level exposure to newer pesticides and mixtures are unknown.
PCBs

- Concentrations of PCBs in tissues wildlife have not declined. In Chesapeake Bay Regions of Concern exposure to PCBs appears to be substantial, and may even contribute to localized reproductive problems.
  - Several bald eagle eggs that failed to hatch had concentrations above residue-effects threshold
Flame retardants

- Moderate concentrations of polybrominated diphenyl ether flame retardants have been detected in eggs from predatory birds in the Chesapeake Bay watershed, and approach the lowest-observed-adverse-effect level for pipping and hatching success.

- Use of the penta-, octa-, and deca-BDE formulations is being phased out, however, and residues in tissues of wildlife are likely to decline.

- Exposure and effects data for new flame retardants (e.g., hexabromocyclododecane and organophosphate flame retardants including tris(3,5-dimethylphenyl)phosphate and tris(1,3-dichloro-2-propyl)phosphate) are lacking for Chesapeake Bay wildlife, and deserve further attention.
Pharmaceuticals and personal care products

- Efforts are currently underway that are examining exposure to a suite of personal care and pharmaceutical compounds in wildlife in order to better determine the extent of exposure and potential effects.
Poplar Island, Chesapeake Bay

July 2012 Bloom of *Anabaena* sp. (blue green alga) and dead common tern. Death attributed to microcystin toxin.
Harmful Algal Blooms

• Interest in the effects of biotoxins, particularly those associated with harmful algal blooms (HABs), on wildlife has increased. A protracted series of heron die-offs that may be linked to microcystins, a potent hepatotoxin from cyanobacteria found in HABs has occurred.

• Global climate change could cause an increase in HABs in the Chesapeake Bay watershed, and adverse effects on waterbird health may be a prominent issue in the foreseeable future.

Research need.