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

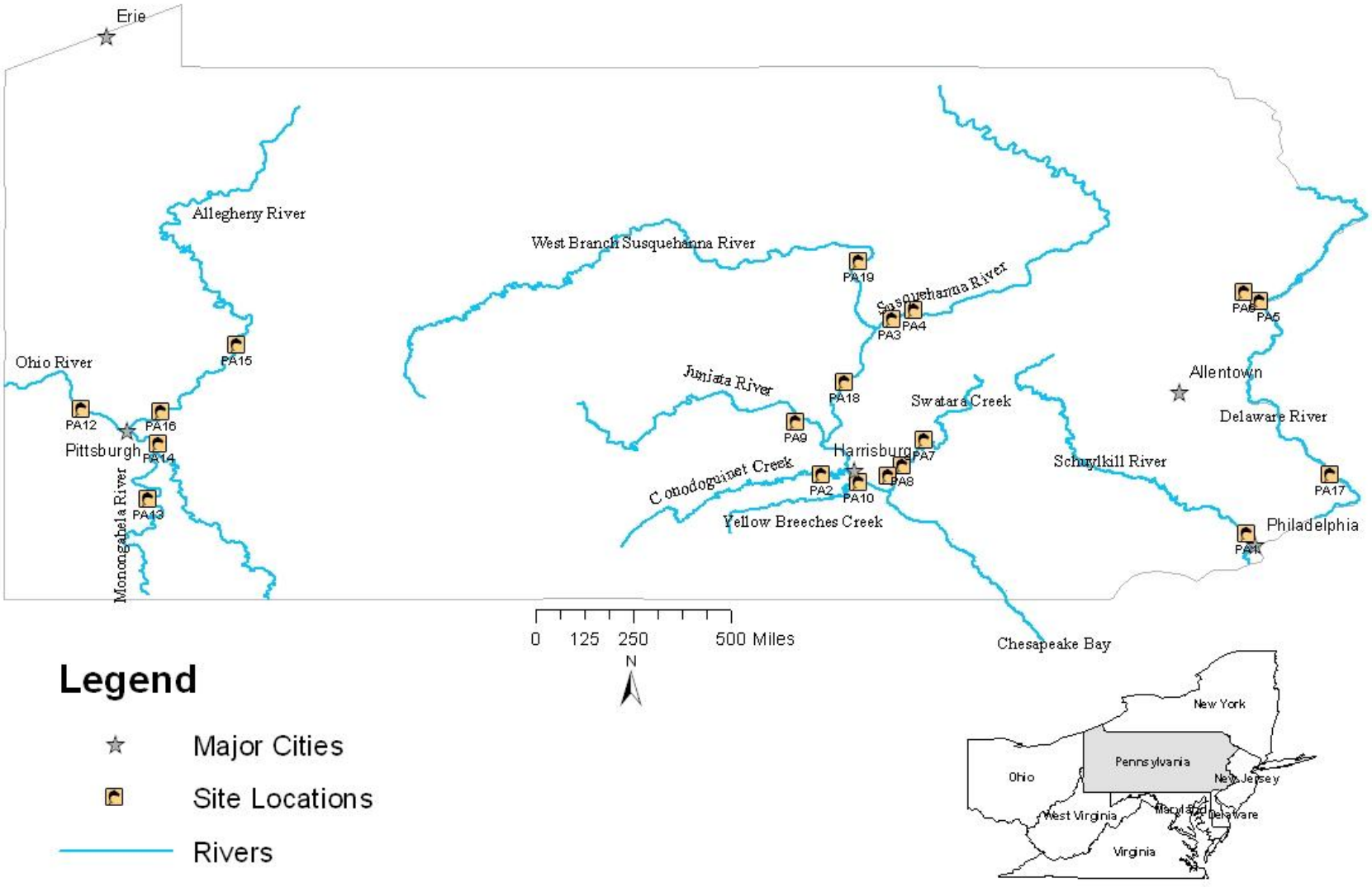
Overview of Intersex Findings

- 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

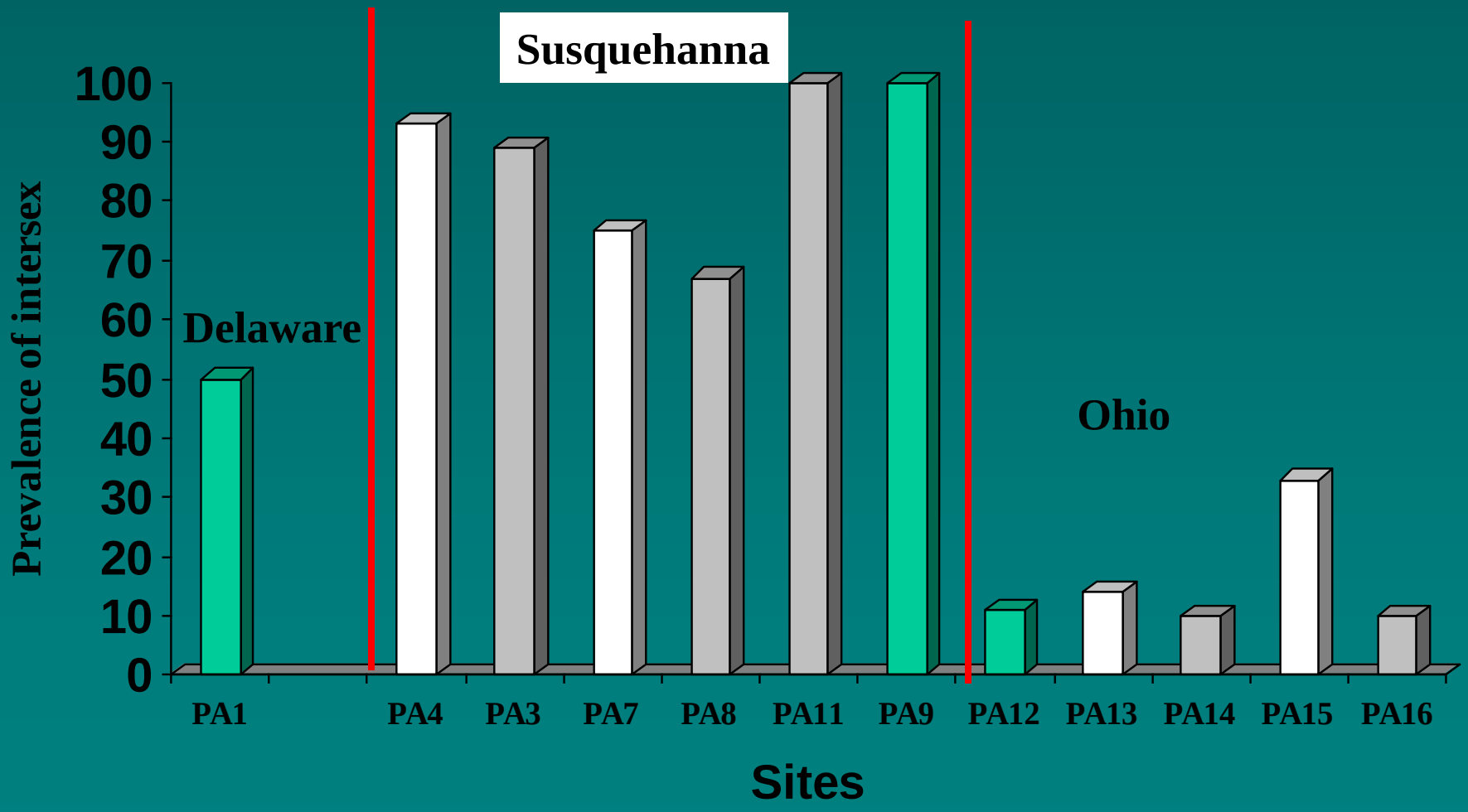
Upstream/Downstream of WWTP

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

Fish Collection Sites in Pennsylvania



Intersex Prevalence
Smallmouth Bass



Intersex and Land-use

Landuse Characteristics	Intersex Prevalence		Intersex Severity	
	r^2	*p*	r^2	*p*
Human population	0.39	0.10	0.42	0.08
# WWTP	0.22	0.24	0.34	0.13
WWTP flow	0.32	0.15	**0.63**	**0.02**
Percent agriculture	**0.63**	**0.02**	**0.50**	**0.05**
# Animal feeding operations	0.28	0.17	**0.56**	**0.03**
Total animal numbers	0.27	0.18	0.48	0.06
Animal density	**0.49**	**0.05**	**0.58**	**0.03**
Poultry Houses	0.27	0.18	**0.50**	**0.05**

Reproductive health of yellow perch in selected tributaries of the Chesapeake Bay

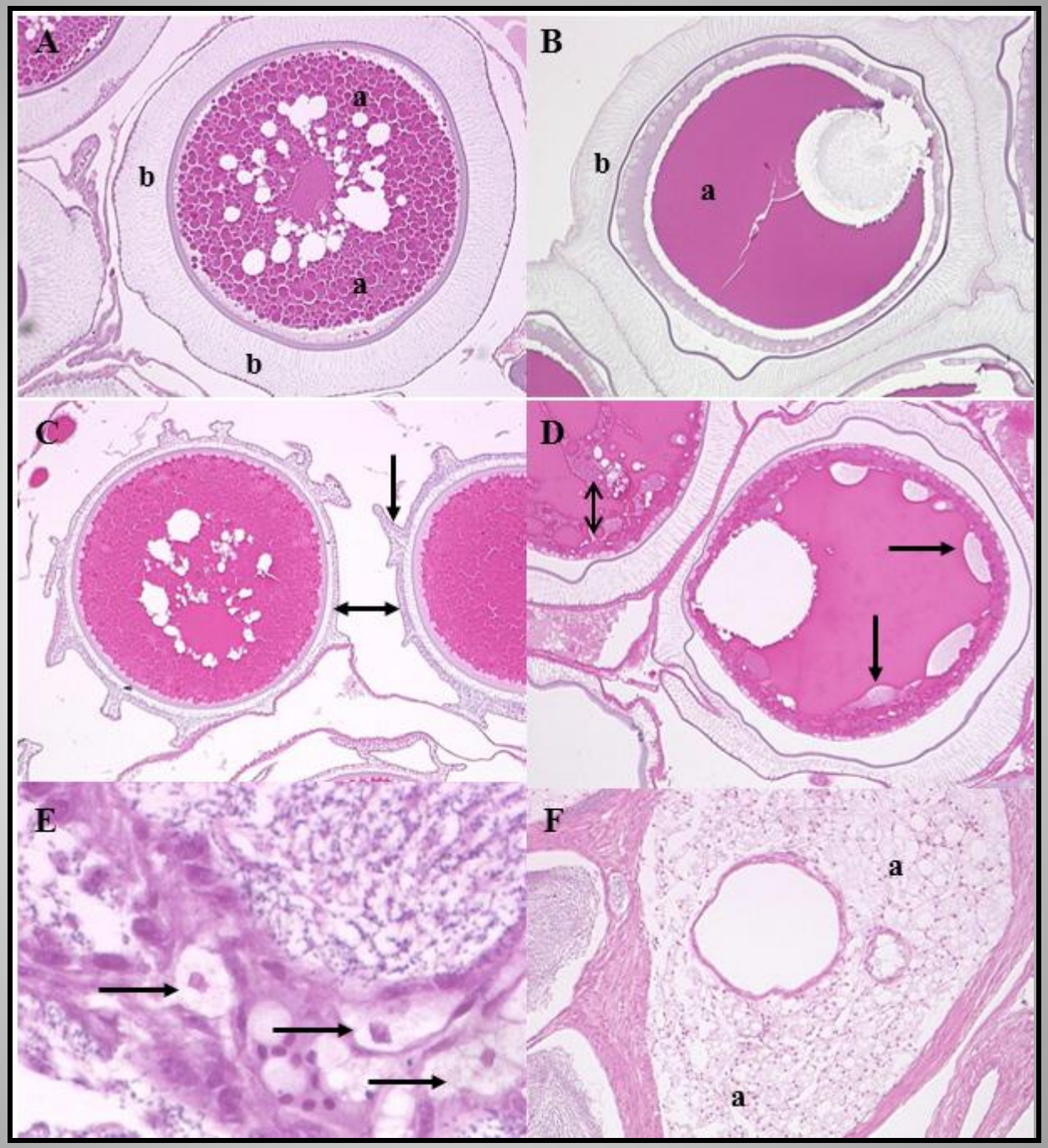
- **Problem**: poor reproduction in western shore tributaries, few viable larvae
- **Approach**: 3-year sampling of males and females during spawning runs: compare Severn, South, Mattawoman, Allen's Fresh, Choptank

- **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

Blazer et al. 2013. Reproductive health of yellow perch in selected tributaries of the Chesapeake Bay. Science of the Total Environment 447:198-209.

Ovary abnormalities

Testis abnormalities

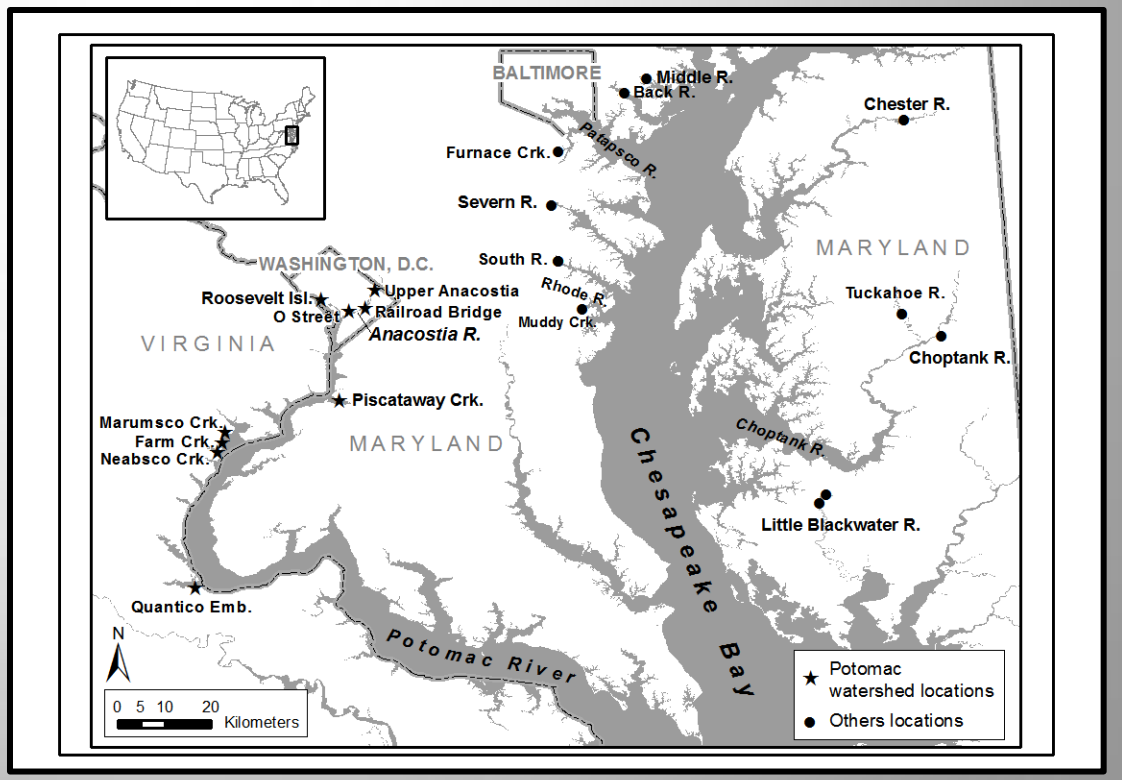


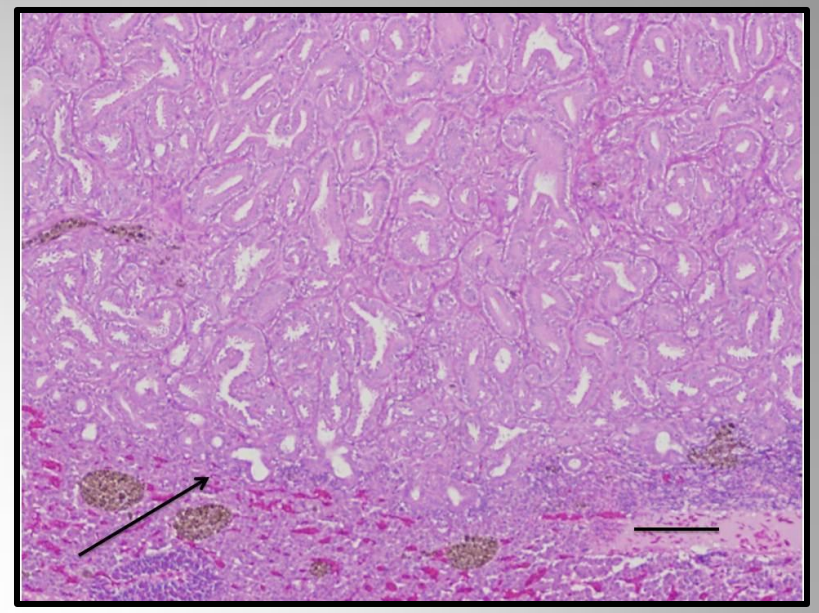
Unanswered questions

- 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?

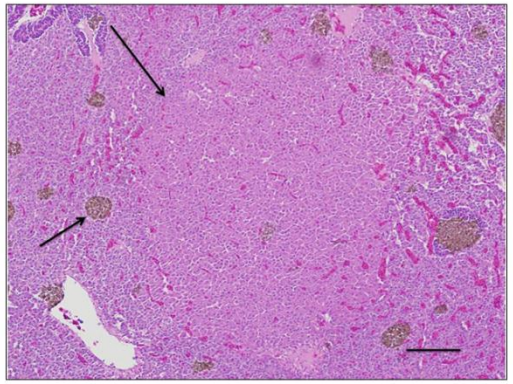
Fish Tumors as an Environmental Indicator

Squamous cell carcinoma: Brown bullhead from the South River





Cholangiocarcinoma



Hepatocellular carcinoma

Liver tumors:
Clear linkage with sediment PAHs

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

Pinkney et al. 2009. Tumors in brown bullheads in the Chesapeake Bay watershed: analysis of survey data from 1992 through 2006. J. Aquatic Aninal Health 21:71-81.

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.

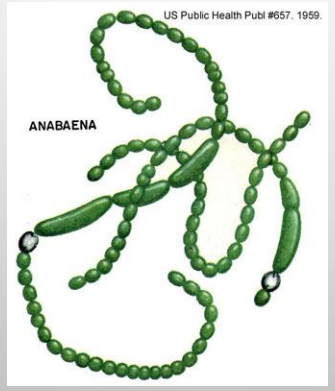
- Exposure and effects data for new flame retardants (e.g., hexabromocyclododecane and organophosphate flame retardants including tris(3,5-dimethylphenyl)phosphate and tris(1,3-dichloro-2-propyl)phosphate) are lacking for Chesapeake Bay wildlife, and deserve further attention.

Pharmaceuticals and personal care products

- Efforts are currently underway that are examining exposure a suite of personal care and pharmaceutical compounds in wildlife is being undertaken 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.**