Chesapeake Watershed Fish Health Workshop:
Summary of findings and recommendations

A workshop entitled *Fish Health in the Chesapeake Watershed: Synthesis and Evaluation* was held January 23-25, 2007 at the U.S. Fish and Wildlife Service's National Conservation Training Center, Shepherdstown, WV. The workshop brought together professionals from diverse fields including fisheries scientists and managers, fish pathologists, microbiologists, ecologists, epidemiologists and toxicologists from MD, Washington DC**,** VA, WV, and PA.
Objectives were to:

- Synthesize what is known about fish health and disease in the Chesapeake Bay watershed including a summary of affected species and disease prevalence.
- Share information among regional experts to identify areas of agreement/ disagreement, common themes;
- Recommend future research, management, and monitoring needs; and look for opportunities to efficiently utilize existing resources and programs.

Background

In 1997, national attention was drawn to the Chesapeake Bay with the occurrence of fish kills and the observation of ulcerous skin lesions in Atlantic menhaden in the Pocomoke River on the Delmarva Peninsula. Initially, the dinoflagellate, *Pfiesteria piscicida*, was thought to be responsible for these events. Subsequent research has shown potential roles of other toxic algae (*Karlodinium veneficum*) in the fish kills and that a fungal pathogen caused the skin lesions. Since then, there have been other disturbing signs that fish populations in the Chesapeake watershed are under severe stress:

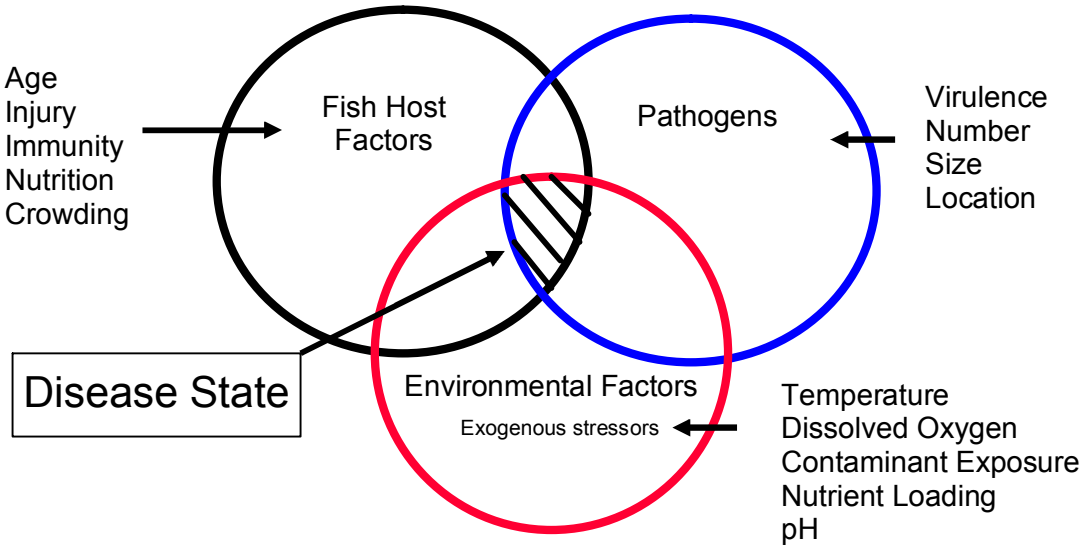

Menhaden with ulcerative lesion

- **Ulcerative lesions** originally attributed to *Pfiesteria,* now known to be caused by the fungal pathogen, *Aphanomyces invadans*, continue to affect menhaden in low salinity waters.
- A large proportion of striped bass (rockfish) in Chesapeake Bay are infected with mycobacteria, the cause of a chronic disease called **mycobacteriosis** that may be adversely impacting the population.
- **Cancerous tumors** have been found in brown bullhead catfish and mummichog. Tumors have occurred primarily in fish from highly contaminated areas (i.e., Anacostia and Elizabeth Rivers), but also in the South River, a suburbanized tributary in Maryland with generally low concentrations of known carcinogenic compounds.
- **Unexplained fish kills** are frequent in the Potomac drainage from 2002 to present. A large fish kill, primarily adult smallmouth bass (SMB), occurred in the South Branch of the Potomac River. Since 2004, fish kills have occurred throughout the Shenandoah River basin. During these events, a large proportion (up to 80%) of the adult SMB were lost. In addition, other fish species were affected and many fish had bacterial lesions, gill damage, and were severely infected with parasites. In 2005, a large fish kill of "young of the year" SMB occurred in the Juniata and Susquehanna basins.
- **A high prevalence of intersex (**immature eggs inside testes) in male SMB and other fish species in the Potomac watershed suggests exposure to endocrine disrupting compounds (EDCs).

Workshop Consensus

Environmental variables play an important role in progression and modulation of disease expression in Chesapeake watershed fishes.

The framework for understanding fish disease depicts the interaction between the environment, the pathogen, and the host and highlights the multifactorial nature of fish health issues. In particular, system-wide eutrophication has initiated a cascade of deleterious water quality changes that may have adversely affected fish, and potentially made them more susceptible to infection.



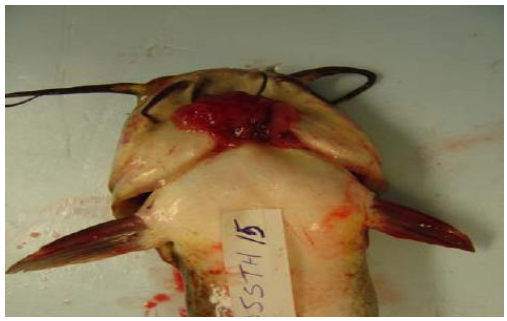
These factors include:

- Hypoxia and anoxia.
- Harmful algal blooms (HABs), such as *Karlodinium,* that can cause fish mortality at high concentrations. The effects of HAB toxins on fish health at chronic low-level concentrations and the role of HAB in freshwater systems are unknown.
- Large daily fluctuations in pH in freshwater systems due to increases in algal biomass.
- Ammonia toxicity in freshwater systems.

In addition, average water temperatures have increased in the region over the last several decades, ~ 2°C in tidal waters and 3° C in some parts of the upper basin, representing an added environmental stressor. For example, high summer temperatures raise the minimum dissolved oxygen level at which fish suffer hypoxia-related stress or mortality, and can reduce available habitat, thus concentrating fish and increasing the likelihood of disease.

Workshop participants also speculated that this combination of nutrient enrichment and elevated water temperature may provide an environment that fosters the growth of fish pathogens and/or stresses fish to the point where they are more susceptible to disease.

With the exception of tumor development in association with polycyclic aromatic hydrocarbon (PAH) exposures, the potential role of chemical contaminants, including EDCs, on fish diseases in the Chesapeake Bay watershed is largely unknown. Nonetheless, literature on contaminant effects in other regions and other taxa forewarn the potential for grave physiological, immunological, and reproductive consequences.



Lesions diagnosed as skin cancer in brown bullheads from the South River, MD

Additionally, participants hypothesized that in some systems, an ecological "tipping point" may have been reached – that is, environmental conditions have deteriorated to the point that fish are sensitive to stressors that under "normal conditions" would have minimal effects.

Population level effects associated with observed fish diseases are largely unknown

- High natural variation in fish population dynamics makes it difficult to discern population level effects of fish diseases. For example, the weight of evidence suggests that natural mortality of rockfish has increased; however, no consensus was reached on whether increased mortality was due to mycobacteriosis or other factors (e.g., food limitation).

- The biological significance of many histopathological endpoints is unclear. For example, it is not known if intersex in SMB causes reproductive impairment.

- Occasional strong year-classes, the ability to spawn more than once and to migrate are features of fish population dynamics that can dampen the impact of density independent mortality. These characteristics explain why, for example, approximately 80% mortality of adult SMB in one region of the Shenandoah River did not appear to affect recruitment in that area the following year

General Management Recommendations

- *Standardize protocols for responding to fish kills across the region and sample collection for the assessment of fish health indicators*. The collection of similar data sets will permit comparisons and analyses between sites and taxa, avoiding problems associated with comparing "apples to oranges".

- *Fund research that will help answer some key questions related to fish disease in the Bay watershed.* Currently, fish health programs in the watershed are largely unfunded, troubling in light of the commercial and recreational importance of some of the affected species. It is worth noting that the finding of intersex SMB in the Potomac River basin was fortuitous in that fish tissues were examined solely in response to the fish kills. Multi-species fish population models that include pathogen and parasite infection, disease, and mortality offer promise and should be supported as one tool for fisheries management in the basin.

- *Because of the plausible link between water quality and fish disease, watershed restoration efforts to reduce input of nutrients, heated stormwater, and other contaminants (e.g., EDCs) to surface waters should be continued and expanded by:*

  - Implementing best management practices to reduce runoff of nutrients and other contaminants from agriculture and urban/surburban stormwater;
  - Reducing the amount of chemicals in waste streams by pollution prevention measures such as reducing the use of feed additives in animal production, educating homeowners on the proper disposal of pharmaceuticals, etc.;
  - Promoting waste treatment practices that could remove or reduce EDCs, pharmaceuticals, and other compounds that have the potential to cause adverse responses; and
  - Monitoring legacy sediment contaminants in largely unmonitored upper watersheds.

- *Fish health metrics should be included as indicators of ecosystem health*. Several species and endpoints look promising and should be considered as part of the expanding list of Chesapeake Bay Program ecosystem indicators. However, participants did not reach consensus on which species/endpoints to pursue (further discussion is required).

By providing a comprehensive overview of critical, known information, the workshop clearly identified knowledge gaps requiring future focus. In the short-term, workshop presentations and additional information will be posted on the Chesapeake Bay Foundation website (http://www.cbf.org/fishworkshop). Over the coming months, more detailed information from the workshop will be compiled in a report which will be available in hard copy and on the web. Finally, overview presentations of the various fish health topics will be submitted for publication in the peer-reviewed literature.

Thanks to the following workshops sponsors: Chesapeake Bay Foundation, Chesapeake Research Consortium, Keith Campbell Foundation for the Environment, NOAA Chesapeake Bay Office, and U.S. Fish and Wildlife Service.

CRC Publication No. 07-162