Rising Watershed and Bay Water Temperatures—Ecological Implications and Management Responses

Ask for STAC Workshop Report Approval

Rich Batiuk

STAC Workshop Steering Committee Member

Co-Founder, CoastWise Partner

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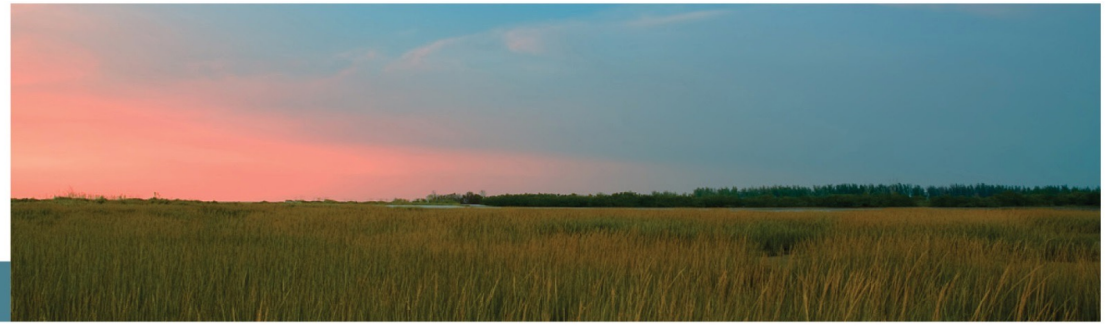
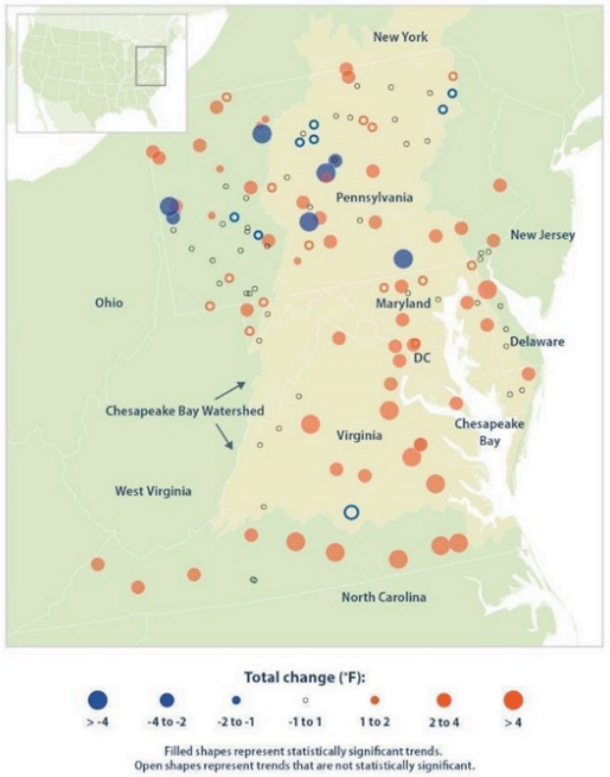
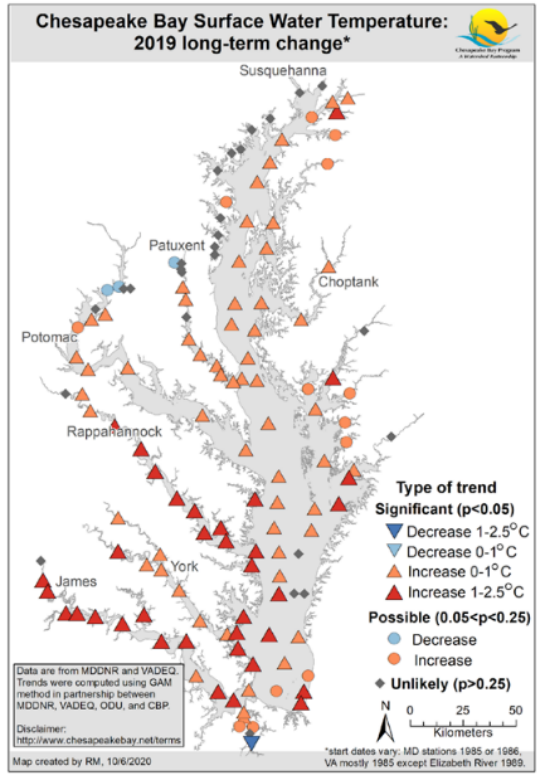


Rising Watershed and Bay Water Temperatures—Ecological Implications and Management Responses





A Scientific and Technical Advisory Committee Workshop Report

STAC Publication 22-003

A Unique STAC Workshop – Two Years in the Making

- Idea for workshop originated with Rebecca Hanmer with workshop proposal initial drafted by Rich Batiuk

- Convened a Steering Committee, Project Team and Synthesis Drafting Teams

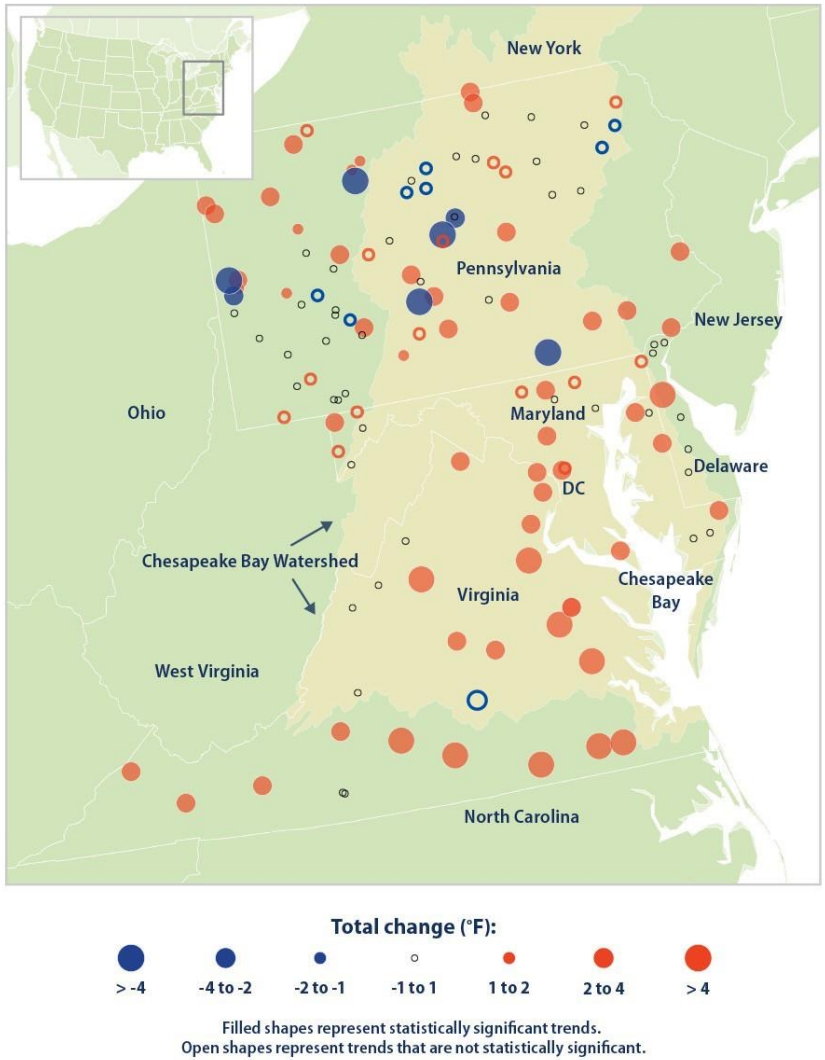
- Addressed the workshop outcomes in three sequential phases including synthesis of the available science and data through 10 papers

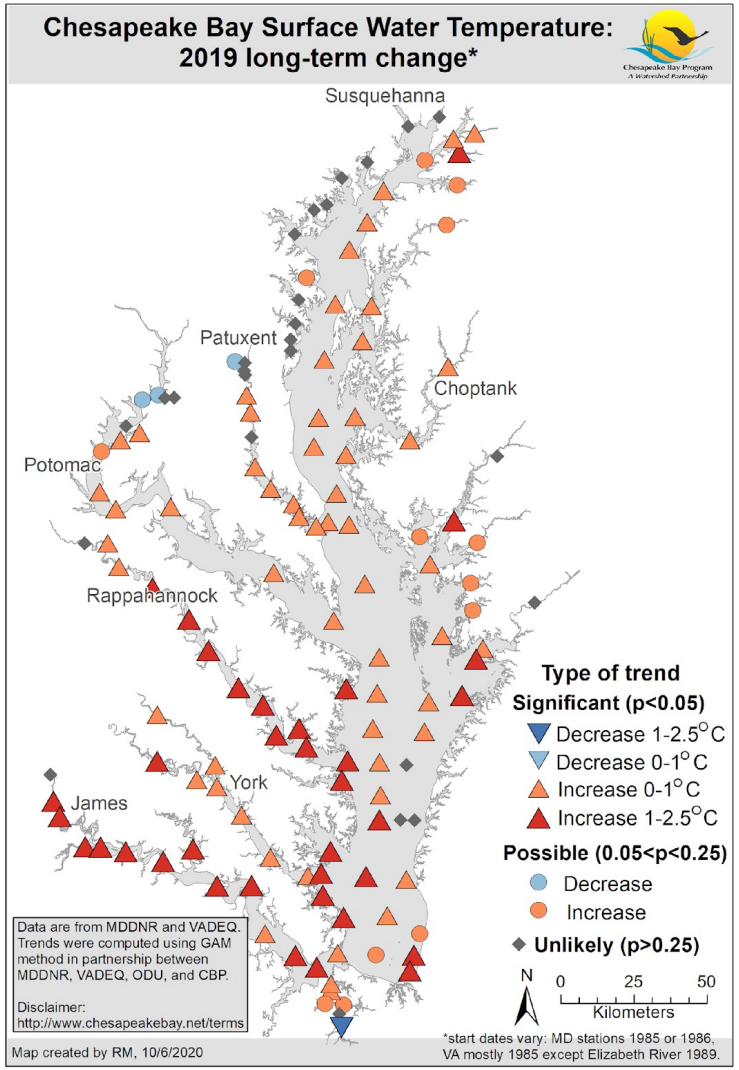
- Hosted series of three one-day work sessions/workshops:
  - Climate Resiliency Workgroup Synthesis Session-June 21, 2021
  - First workshop-January 12, 2022
  - Second workshop-March 15, 2022

A Unique STAC Workshop – Watershed/Tidal Focus

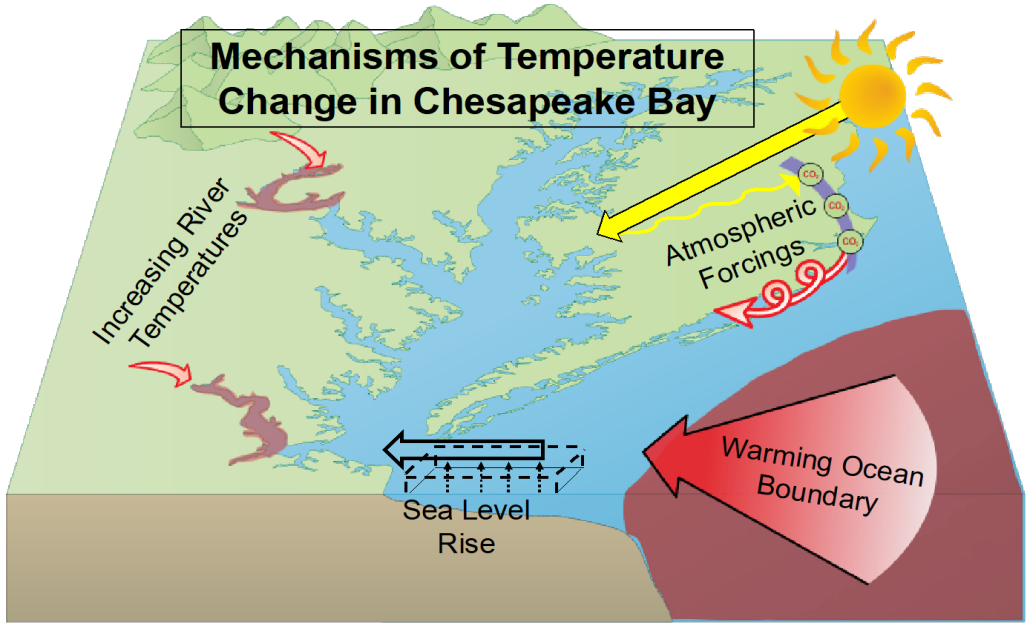
- Findings from prior work session/workshop set the stage for the next workshop
- Both one-day workshops structured with parallel sessions focused on the watershed and the tidal waters lead by Katie Brownson and Julie Reichert-Nguyen, respectively
- The January workshop focused on identification of the ecological impacts and management implications
- The March workshop focused on development and refinement of management recommendations

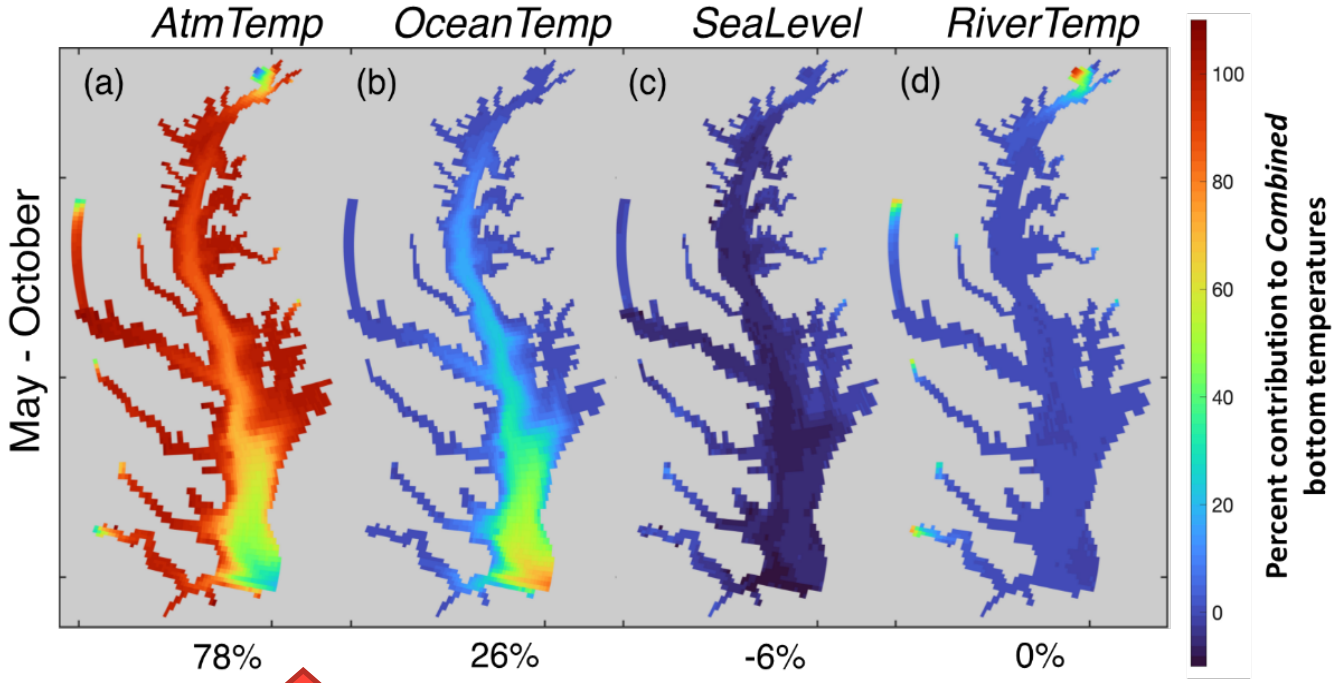
Water Temperatures are Rising





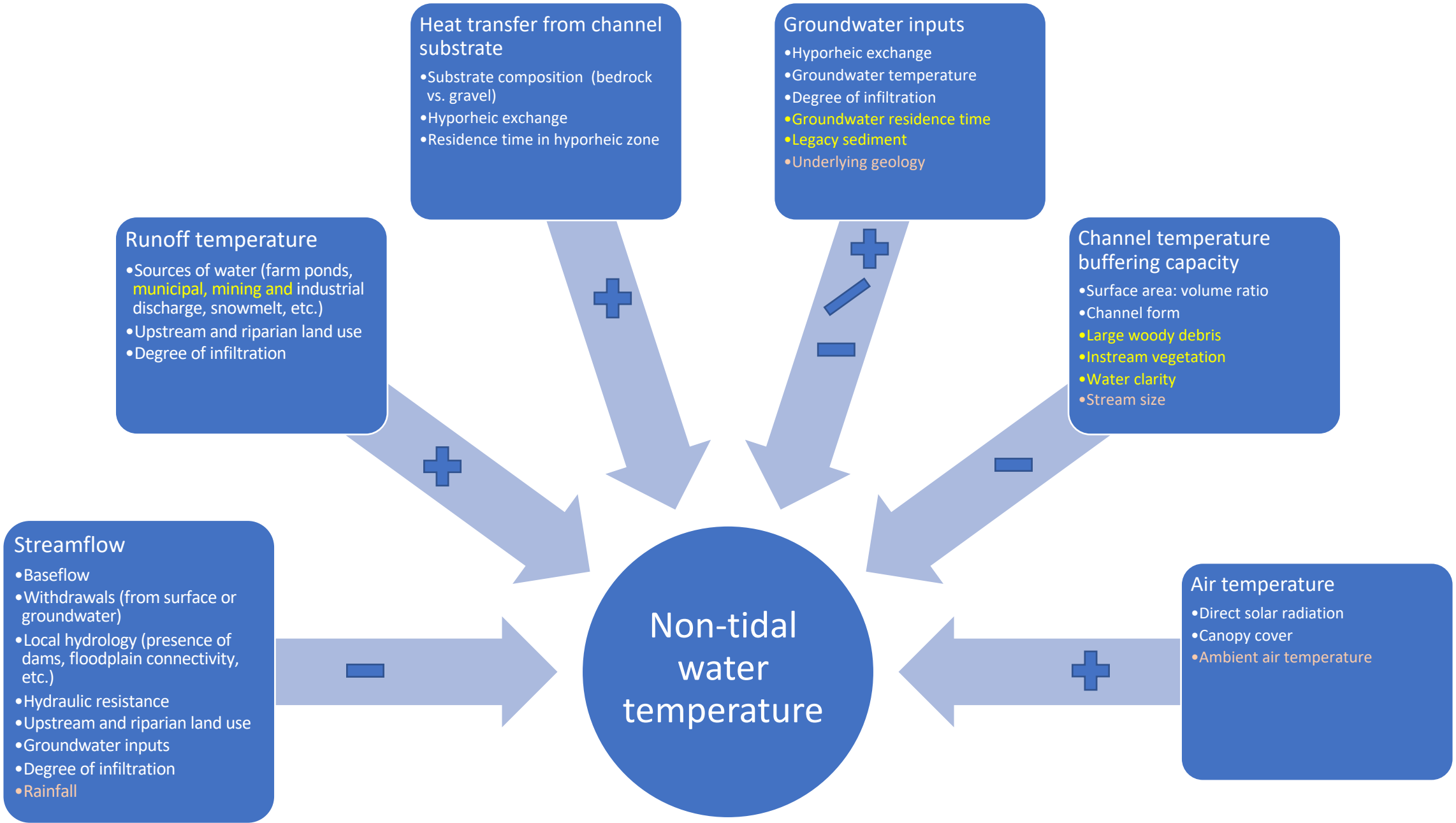
Air and Ocean Temperatures are Key Drivers for Tidal Waters





1) Air temperatures ⬆
2) Ocean temperatures ⬆
3) Sea level rise ⬇
4) River temperatures ⬆

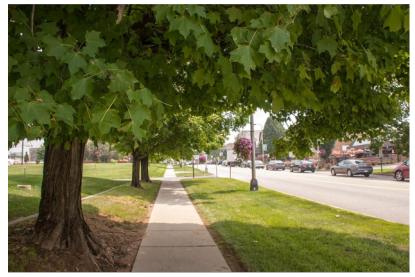
Increasing stream and river temperatures have been driven by rising air temperatures, but other drivers have a strong influence



BMPs

Conservation

Land use practices



Watershed

Mitigation
Lowering of Water Temps

Tidal &
Watershed

Adaptation
Minimize Impacts & Adjust

Submerged Aquatic Vegetation (SAV)

Oysters

Blue Crabs

Forage

(Menhaden, Bay anchovy, benthic invertebrates)

Striped Bass

Brook Trout

Watershed Ecological Impacts - Species

- **Strongest negative impacts** on coldwater species (e.g., trout, sculpin) and their habitats (esp. where streams aren't driven by groundwater)

- Watershed-wide, warmwater aquatic species are most common. Although more tolerant to temperature increases, they are **sensitive to extreme temperatures** including rapid changes and to indirect effects (e.g., invasives, pathogens) from higher temps.

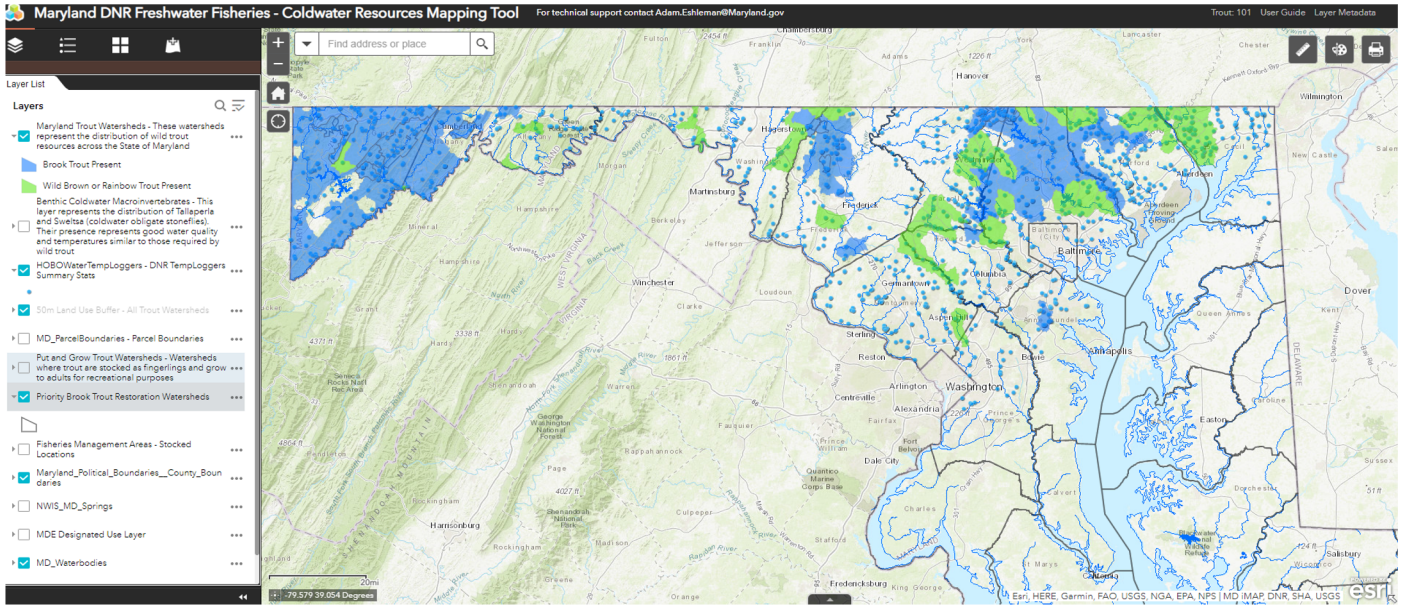
- **More study needed** of temperature effects on lower foodweb
  - Algae, biofilms, zooplankton
  - Macroinvertebrates
  - Freshwater mussels & host species

Ecological Impacts - Other Stressors

- **Co-occurring Stressors**
  - Low dissolved oxygen
  - Invasive species
  - Algal blooms
  - Bacterial/viral outbreaks
  - Distribution & toxicity of other pollutants (e.g., heavy metals, pesticides, ammonia, etc.)
  - Expansion of invasives

Coldwater Fisheries and Habitat Recommendation

- Accelerate conservation to protect the coldwater streams now supporting healthy aquatic life…and **continue resiliency analyses and mapping to focus coldwater habitat restoration efforts**.

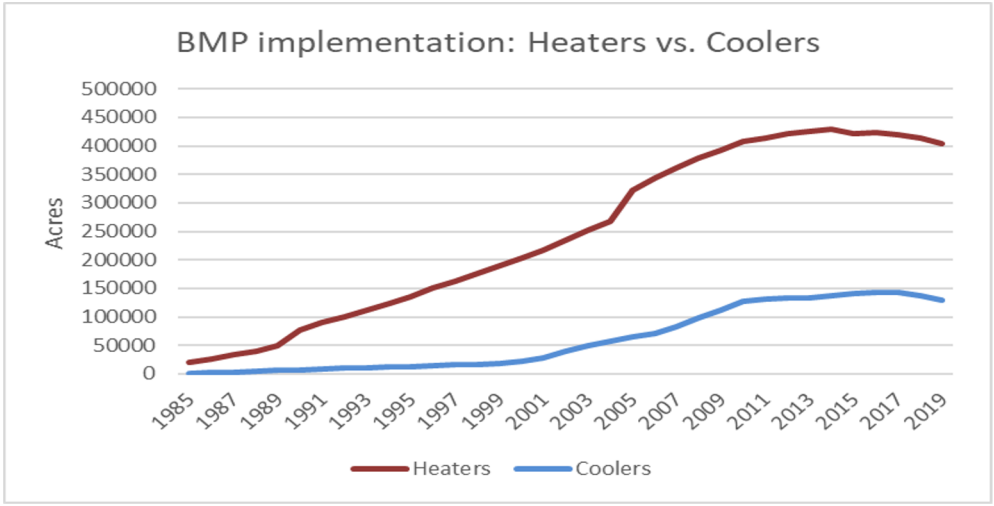


Rural Waters and Habitats Recommendation

- Work to strategically restore forests and aquatic habitats **while promoting good agricultural stewardship practices that can reduce the amount of heated runoff** being generated by farms

Best Management Practices Recommendation

- Work to minimize the extent to which water quality BMPs are further **heating waterways** and strategically use **cooling BMPs** to counteract the warming effects of climate change and land use where possible

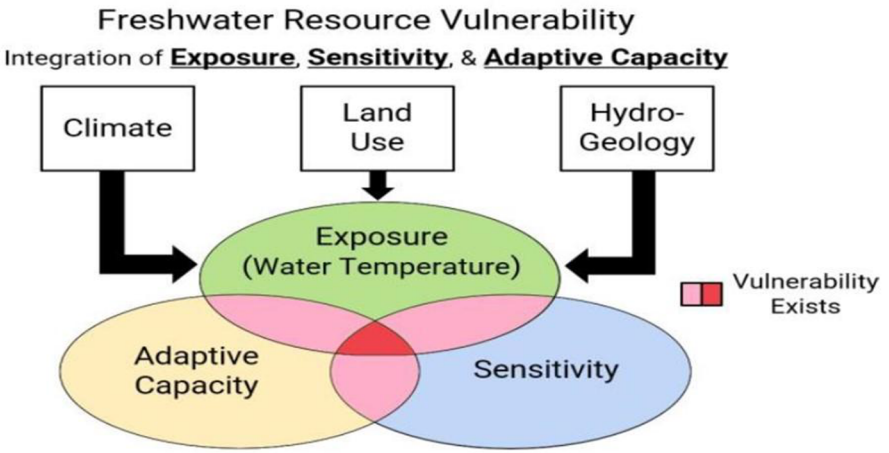


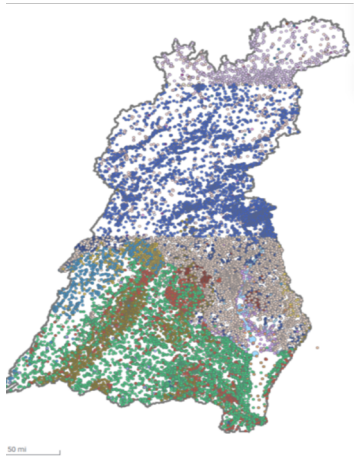
State Temperature Water Quality Standards Recommendation

- The states and EPA should **review and modernize** the components of current WQS systems that would strengthen their capability to address climate-related rising water temperatures and **drive area-targeted protection and restoration strategies**

Overarching Recommendation for Research

- Enhance and facilitate partnership efforts to collect data and develop tools needed to fill critical knowledge gaps, **improve understanding of the impacts of rising temperatures on aquatic ecosystems**, and inform management decisions



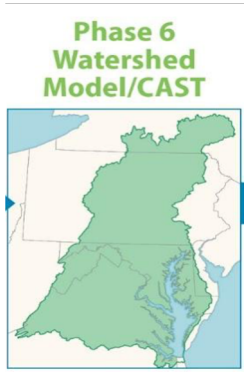


Overarching Recommendation for Monitoring and Analysis

- **Increase monitoring of water temperature in smaller streams**, and further analyze existing data from larger streams and rivers, to improve understanding of the effectiveness of restoration and conservation of stream communities and fisheries in the face of land-use and climate change

Overarching Recommendation for Watershed Modeling

- Develop new modeling tools and **expand the use of CAST and the Chesapeake Healthy Watershed Assessment** to better inform the management of watershed fisheries and ecosystems



Ecological Implications

Fisheries:

- Positive impacts are likely for blue crab and some forage species
- Negative impacts are predicted for oysters
- Striped bass may experience both negative and positive

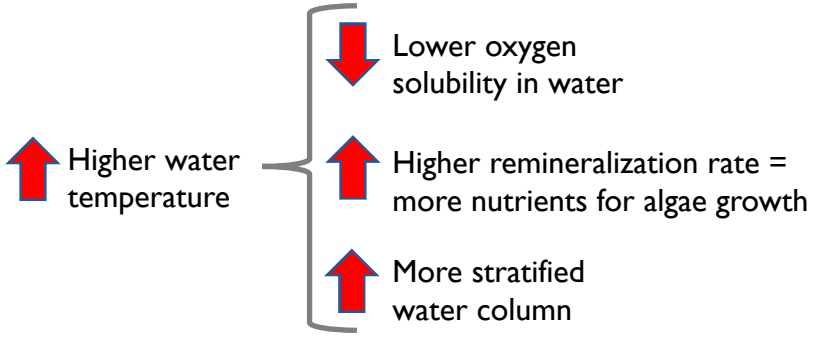
Positive
Direct
Increased growth rates & earlier maturation
Reduced winter mortality (blue crabs & oysters)
Indirect
Longer spawning seasons and/or growing seasons
More algae/food (oysters

Negative
Direct
Reduced survival due to detrimental temperature ranges (more so during early life stages
Indirect
Increased hypoxic conditions
Ocean acidification
Increases in pathogens/disease occurrence
Alternation in food resources (abundance & quality
New non-native predators

Submerged Aquatic Vegetation:

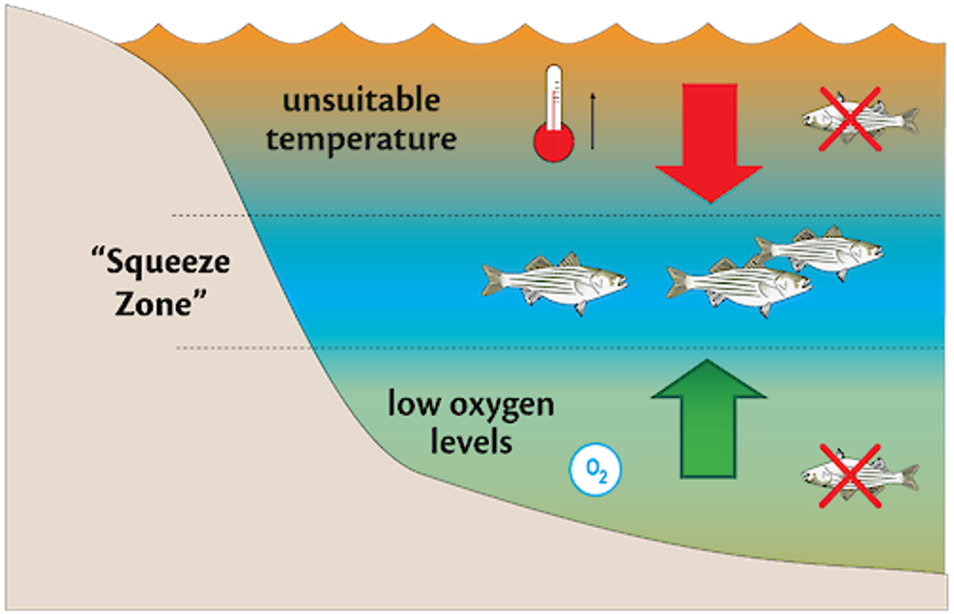
- Viable populations of eelgrass likely to be extirpated
- Impacts to other SAV not as well studied
- CO_2 fertilization effect may provided some counterbalance to impacts of warming

Implications of Ecosystem-Level Effects on Living Resources



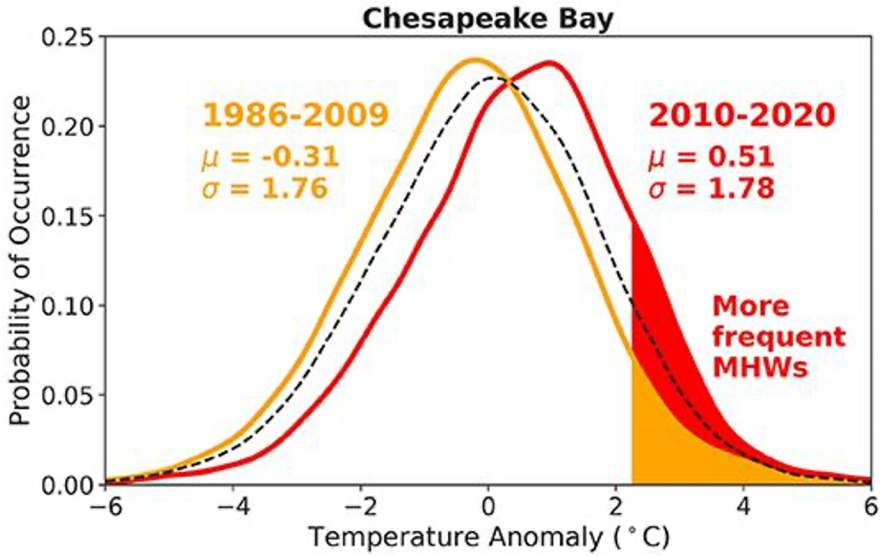
All combined = even lower dissolved oxygen

Squeeze Zone for Striped Bass



Conceptual diagram illustrating the compressed habitat of the striped bass from the low oxygen levels from the bottom, and the unsuitable unsuitiable tempatures on the top waters.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Enviromental Science. Source: Boesch, D.F. (editor). 2008. Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland. Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change. University of Maryland Center for Environmental Science, Cambridge, Maryland. This report is a component of the Plan of Action of the Maryland Commission on Climate Change, submitted to the Governor and General Assembly pursuant to Executive Order 01.10.2007.07.

- Shifts in species ranges and habitats
- Some Bay species' populations are shifting north while other species from the south are becoming more prevalent in the Bay
- Changes in the intensity, duration, & frequency of marine heat wave events & effects on survival



Source: Mazzini and Pianca 2022

Ecosystem-Based Management & Temperature Regime Recommendation 1

- Establish Chesapeake Bay wide Striped bass fishing guidance based on temperature and dissolved oxygen thresholds **to reduce catch and release mortality**
- Consider developing habitat condition thresholds and fishing guidance for other recreationally targeted species **at risk during periods of poor habitat conditions**

Associated Science Needs

- Determine **temperature and oxygen thresholds** for striped bass and other key species.
- Conduct investigations to better understand **behavior of anglers** on the water
- Develop **habitat suitability models** and indicators for key fishery resources

Ecosystem-Based Management & Temperature Regime Recommendation 2

- Develop and implement a strategy to **improve communications** between living resource managers, scientists and stakeholders on the **new temperature regime**, the impacts and management response/adaptation strategies

Associated Science Needs

- Understand where the gaps are in our current communication strategies
- **Social science research** to help understand decision making (e.g., understanding behavior of anglers on the water when throwing back or keeping catches, understanding property owners' choice in shoreline protection)
- Development of communication strategies to specific audiences (e.g., policy-makers, managers, residents, local partners)

Ecosystem-Based Management & Temperature Regime Recommendation 3

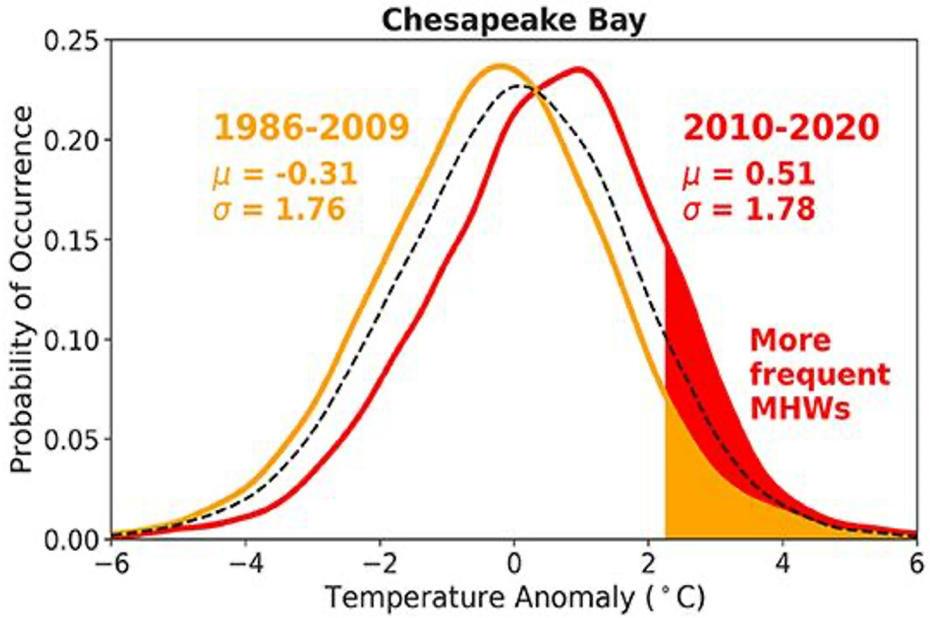
- Hold a workshop with multiple fishery stakeholders to explore strategic, long- term ways to **advance ecosystem approaches to fishery management** in the Bay that incorporate climate change

Associated Science Needs

- Improve environmental monitoring of surface and bottom temperature, dissolved oxygen and fish habitat condition
- Explore a State of ecosystem report level synthesis for the Chesapeake Bay to track how climate change is progressing and for use by managers to adapt actions addressing the changes appropriately
- Better understanding of physiological response of certain species
- Explore assessments for emerging fisheries to facilitate management as climate change creates conditions for these fisheries to be economically viable
- Consider establishing monitoring stations where there are significant fisheries habitat and spawning grounds (long-term monitoring currently is more set up to characterize large bay segments)
- Evaluate need for zooplankton monitoring at spawning and nursery areas
- Improve information on drivers of natural mortality and recruitment success for key fishery species and build into ecosystem models- inclusion of how climate change will affect fisheries

Multiple Stressors Recommendation

- An interdisciplinary team of scientists, resource managers, meteorologists, and communicators should collaborate to design and **create a publicly available heat wave alert system**.



Associated Science Needs

- Review current definitions of heat waves and conduct research to determine an appropriate definition for Chesapeake Bay (or tributaries as appropriate)
- Explore real time monitoring of marine heat waves and need for forecast products
- Link heat waves to living resources by analyzing heat waves and fishery survey data such as ChesMMAP
- Incorporate dissolved oxygen and link to habitat preferences of key species such as striped bass, blue crabs, oyster, and SAV
- Development of the warning system
- Outreach to public, and to partners in development

Nearshore Habitat Recommendation

- Develop common criteria and metrics to help target, site, design and implement tidal natural infrastructure projects in the nearshore **where ecological and climate resilience benefits are highest**

Associated Science Needs

- Detailed analysis of costs of natural infrastructure versus hardened infrastructure
- Threshold analysis of ecological impacts and benefits
- Research into behavioral drivers behind shoreline hardening decisions
- Development of criteria for targeting where multiple benefits and ecosystem services can be optimized.
- Use of models to increase understanding of habitat change from sea level rise

Responses to Comments Received

- 18 participants in the workshop commented when the draft report was sent out for review
- The bulk of the comments were received from members of the workshop project team who had previously contributed to the synthesis papers and/or preparations for the two workshop days
- Almost all of the comments were on the Watershed section of the report, and concentrated on the findings and the “rationale” paragraphs accompanying the recommendations
- A few comments were made on the recommendations and implementing actions
- Where editorial clarifications were suggested, changes were accepted
- No changes were made in the recommendations, and no implementing actions were added or deleted
- We separate documentation of responses to both key comments and all comments

Final Notes

- We ran into challenges with recognizing USGS and EPA research colleagues as contributing authors of the workshop report given its contains management recommendations

- Please be aware several synthesis papers are undergoing USGS reviews and some further edits may be incorporated

- UMCES colleagues are working on an 8-page summary paper to communicate the workshop findings and recommendations to a broader audience

Final Asks

- Rebecca and I were able to champion the workshop, from proposal through delivery of the final draft workshop report
- However, we can't champion the follow through on the management actions
- I ask STAC to challenge the Management Committee to integrate the management recommendations (and associated science needs) from the STAC workshop into plans for implementation of the *Chesapeake Executive Council's Directive No. 21-1 Collective Action for Climate Change*
- I ask for STAC's approval to finalize and publish the STAC workshop report