Setting the Stage - Ecosystem Management and Relevant Living Resources Efforts to Inform Climate Model 3.0

Joint Climate Resiliency, Urban Stormwater, and Modeling Workgroup Meeting

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Acknowledgements: Brooke Landry (MDNR, SAV Workgroup), Molly Mitchell (VIMS, CRWG), Bruce Vogt (NOAA, Fisheries GIT), and Jamileh Soueidan (CRC, CRWG)

CBP and Partner–Supported Efforts

- Rising Water Temperature STAC Workshop Report and Follow-up Activities and Research (CBP Climate Resiliency, Forestry, NOAA)
- Marsh Adaptation and Marsh Migration Corridor Envelope (CBP Climate Resiliency, Wetlands, GIS Team)
- Submerged Aquatic Vegetation (SAV) Climate Model Synthesis (SAV Workgroup, Climate Resiliency)

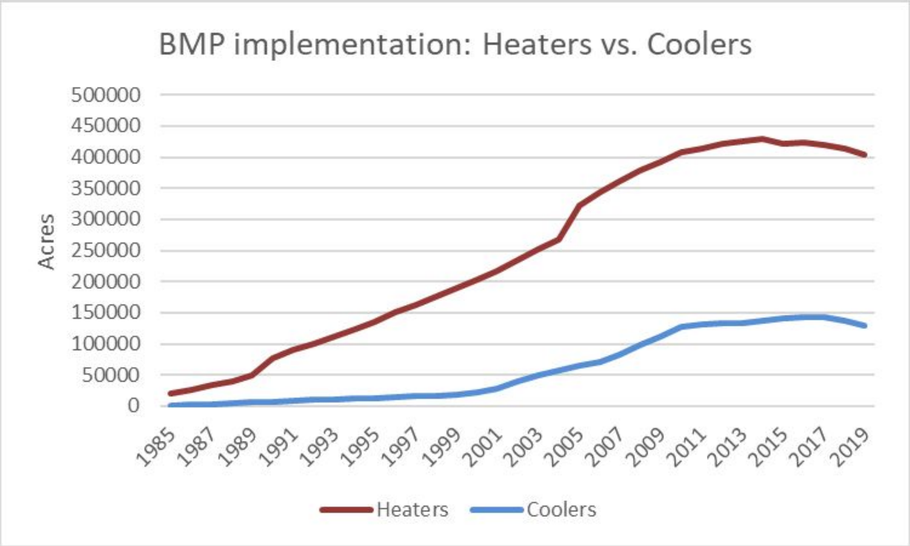
Rising Water Temperatures STAC Workshop Report

Agreement across the Partnership on the urgency to do more in better preparing the region for rising water temperature impacts on water quality, habitat, and living resources goals.

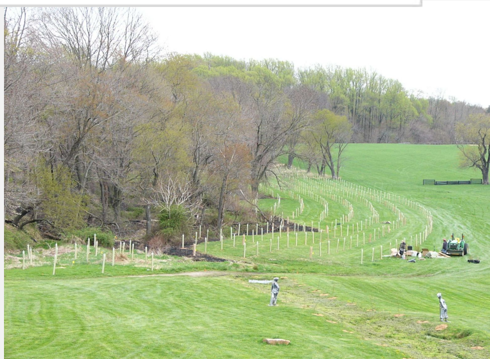
Workshop report includes information and recommendations for nontidal and tidal waters on:

- Major findings on the ecological impacts of rising water temperatures, including science-based linkages between causes and effects, on tidal and watershed living resources.
- How to mitigate these impacts through existing management instruments, ranging from identifying best management practices to adapting policies and analytical approaches.

What can Bay Program partners do to help moderate rising water temperatures?

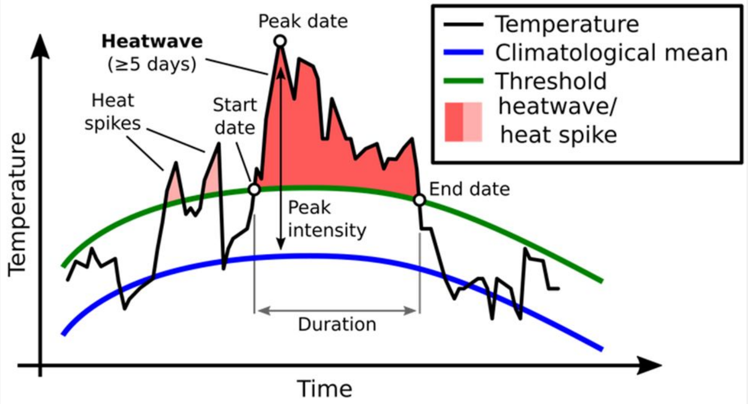


- **Prioritize best management practices that cool or moderate water temperatures**, including riparian forest buffers and upstream tree planting, paying particular attention to vulnerable ecosystems and communities
- **Provide information needed to improve local land use decisions**
    - **Increase forest conservation,** particularly in coldwater watersheds
    - **Increase infiltration and minimize impervious surfaces**



What can Bay Program partners do to help adapt to rising water temperatures?

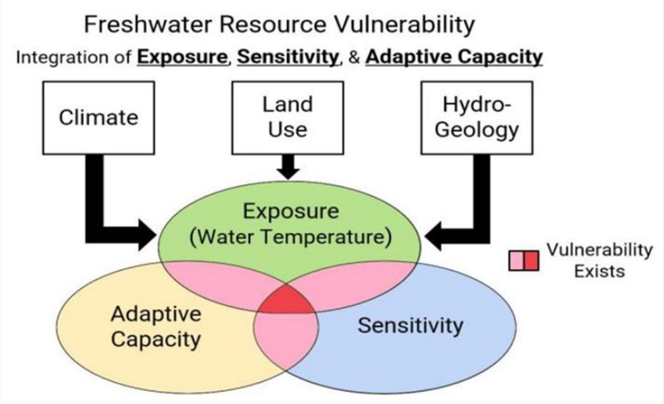
- Develop BMP design recommendations to create or maintain thermal refugia, especially during summer heatwaves
- Improve connectivity by restoring habitats and/or removing barriers to suitable cold and cool water habitats

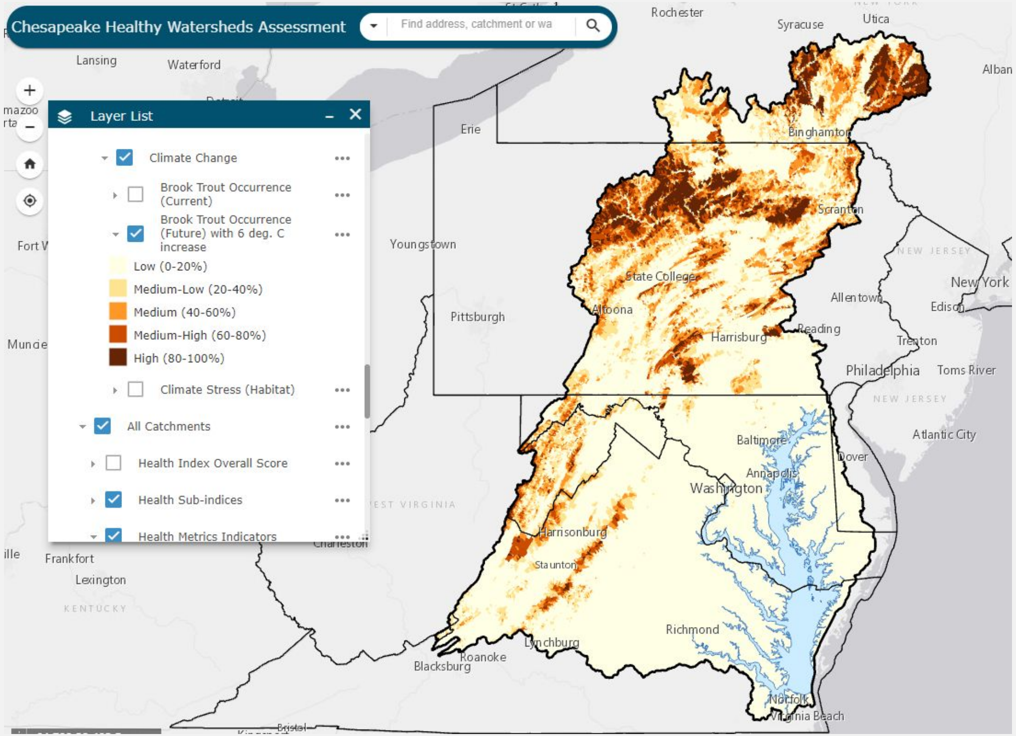


marineheatwaves.org

What can Bay Program partners do to advance science around rising water temperatures?

- Advance understanding of how BMPs influence water temperature
- Continue resiliency analyses and mapping to focus coldwater habitat restoration efforts.
- Improve water temperature monitoring and modeling to better inform management





What are some implications of this report for 2025 and Beyond?

- Warming water temperatures will make it more difficult to reach our 2025 TMDL water quality goals and multiple Watershed Agreement goals (Brook trout, Stream Health, Healthy Watersheds, Fish Habitat, Blue Crab Abundance, SAV, etc.)
- Moving beyond 2025, water temperature should be incorporated more explicitly into the goals, outcomes and management strategies of the Partnership to better achieve both water quality and living resources goals
  - This will require additional (and more integrated) science, monitoring and modeling!

Current and Upcoming Efforts

- Current GIT funding project: **Optimizing Riparian Forest Buffer Implementation for Climate Adaptation and Resilience**
  - Goal: Increase and optimize RFB implementation by synthesizing and communicating information about the climate adaptation and resilience benefits of RFBs
- Proposed GIT funding project: **Assessment of BMPs as heaters and coolers for local waters**
  - Goal: Providing managers with information needed to help prioritize the implementation of "cooler" BMPs, particularly in sensitive coldwater watersheds
  - Would build on current USGS efforts to evaluate the water temperature (and other stream health) impacts of BMPs in small watersheds
- **Beyond 2025 small group recommendations**:
  - Healthy Watersheds: Shift to an outcomes-based approach to promote protecting, restoring and maintaining watershed health
  - Climate: Develop and implement a framework for a climate adaptive Bay and watershed of the future; Promote strategies for healthy and productive ecosystems under changing climate conditions
  - Shallow Waters: Design and implement system-scale habitat restoration that provide resilience and connectivity under changing land-use and climate conditions, Expand watershed monitoring and modeling to include continuous shallow water habitats, Implement an active approach to climate adaptation

Rising Tidal Water Temperatures

Bottom Line:

Chesapeake Bay of the Future will not be the Chesapeake Bay of the Past

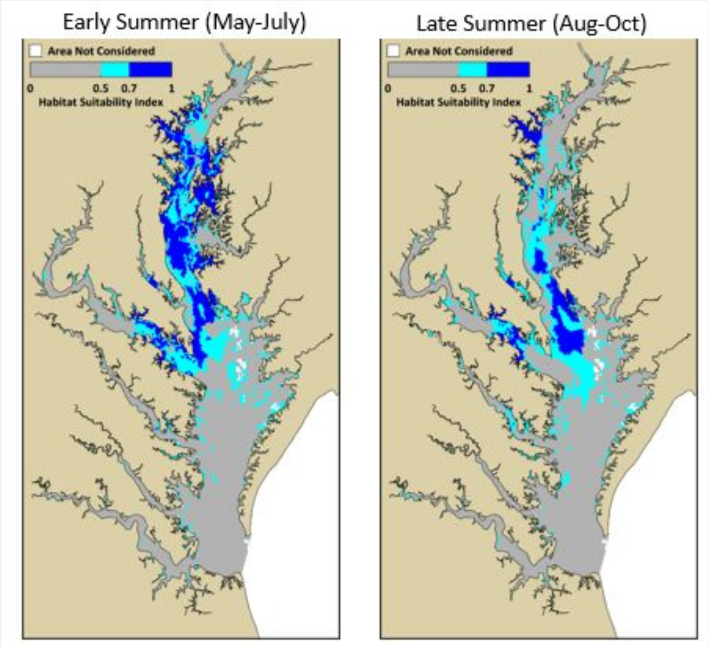
- Bay water temperatures are increasing and will continue to increase – affects all water quality, living resources, and habitat outcomes in the Watershed Agreement.
- Recommendations focuses on adaptation and resilience strategies involving ecosystem-bas management, maximizing nearshore habitat benefits while minimizing negative impacts, tracking extreme stressors, and preparing for future conditions.

Photo: Will Parson, Chesapeake Bay Program

Photo: Peter McGowan, USFWS

IDENTIFIED SCIENCE NEEDS:
ECOSYSTEM-BASED MANAGEMENT—ANALYSES AND MODELING

- Synthesize existing science to establish habitat condition thresholds based on temperature and dissolved oxygen for key fisheries species (e.g., striped bass, summer flounder).
- Develop habitat suitability models and indicators for key fisheries resources.
- Research how loss of late-winter/spring eelgrass habitat will affect blue crab populations.
- Build into ecosystem models, improved information on drivers of natural mortality, recruitment success, and climate change impacts for key fishery species.
- Support assessments for emerging fisheries as climate change creates favorable conditions for these fisheries to be economically viable.



Example from Striped Bass Habitat Suitability Study (Dixon et al. 2022)

Marine Heatwave Alert System

- Convene an interdisciplinary team of scientists, resource managers, meteorologists, and communicators to design and create a publicly available marine heatwave alert system.
- Connect alert system with habitat preferences of key species and guidance on fishing behavior. Consider incorporation of other key parameters (e.g., dissolved oxygen, salinity).

Example from Maryland Department of Natural Resources

NOAA Chesapeake Bay Office Marine Heatwave Product

(Under Development)

Roadmap

Jamileh Soueidan, CRC and
Julie Reichert-Nguyen, NOAA

Marine Heatwave Analyses

- Evaluate Marine Heatwave definitions and needs with climate and fisheries experts
- Determine and conduct analysis with available NOAA Buoy and Satellite data
- Address data limitations

Communication Products

- Incorporate into NCBO Seasonal Summaries
- Development of Marine Heatwave–Fisheries Impact Indicator(s) - assess use on Chesapeake Progress

Incorporation of Marine Heatwave Forecasting

- Incorporation of marine heatwave forecasting data and modeling into analyses

Development of Marine Heatwave Alert System

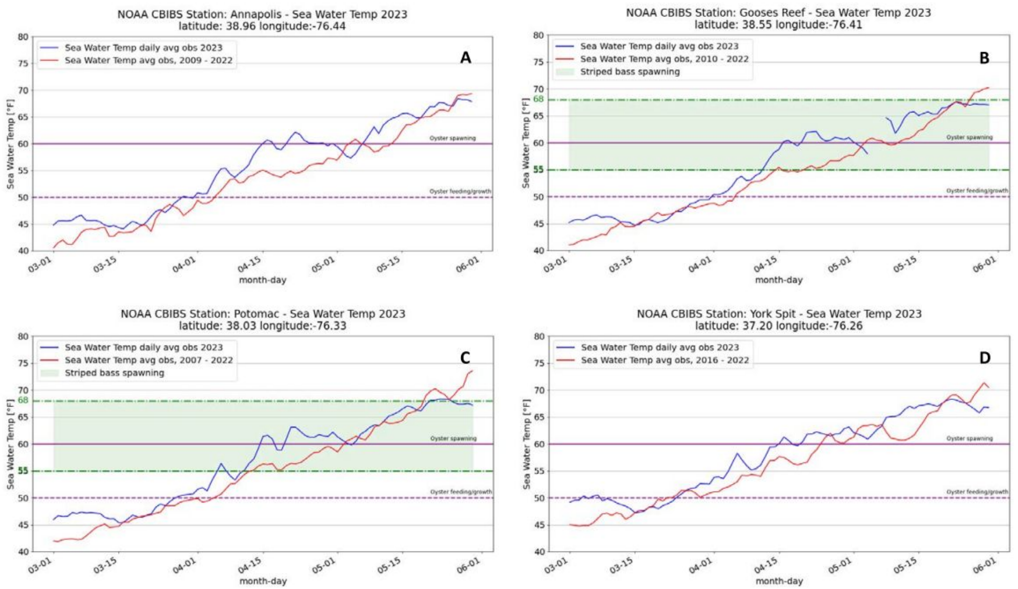
- Building from the analyses and products, create a publicly available marine heatwave alert system linked to fisheries impacts

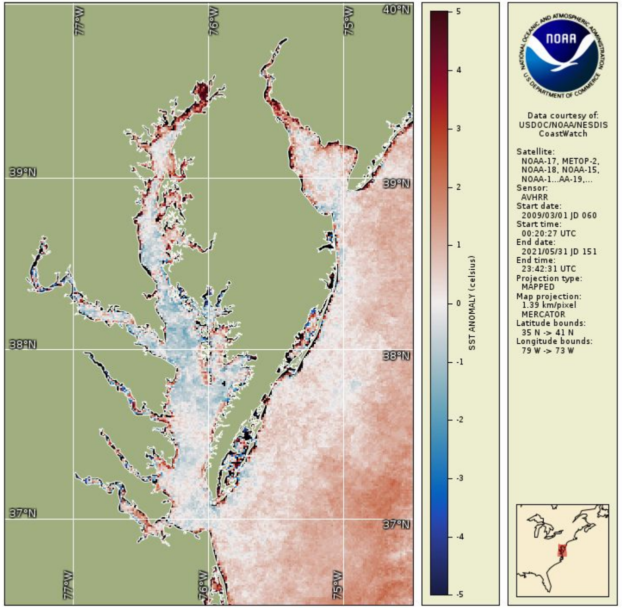
Highlights – Feedback from Climate and Fisheries Experts

- Evaluating marine heatwaves have value depending on the fish impact question:
  - Shifts in community structure – e.g., decrease in striped bass and increase in species from the south.
  - Acute stress on present species in Bay (periods of higher vulnerability).
- Marine heatwaves can happen throughout the year; this could have implications depending on the life stage of fish being evaluated. Consider other extremes (e.g., cold snaps), which could have species-level impacts.
- Consider different types of thresholds that can be utilized; can be based on species physiology or habitat condition or a combination.
- Integrate information on future climatology from climate change scenarios to inform tipping points where Chesapeake Bay habitats will likely not be tolerable for a species of fish.
- Explore how efforts can inform resilience work, especially in targeting multi-tiered nature-based strategies to provide thermal refugia.

NOAA Chesapeake Bay Seasonal Summaries

- Quarterly reports using existing environmental observational data to craft narratives about impacts on living resources (e.g., water temperature/SST anomalies, salinity, flow)



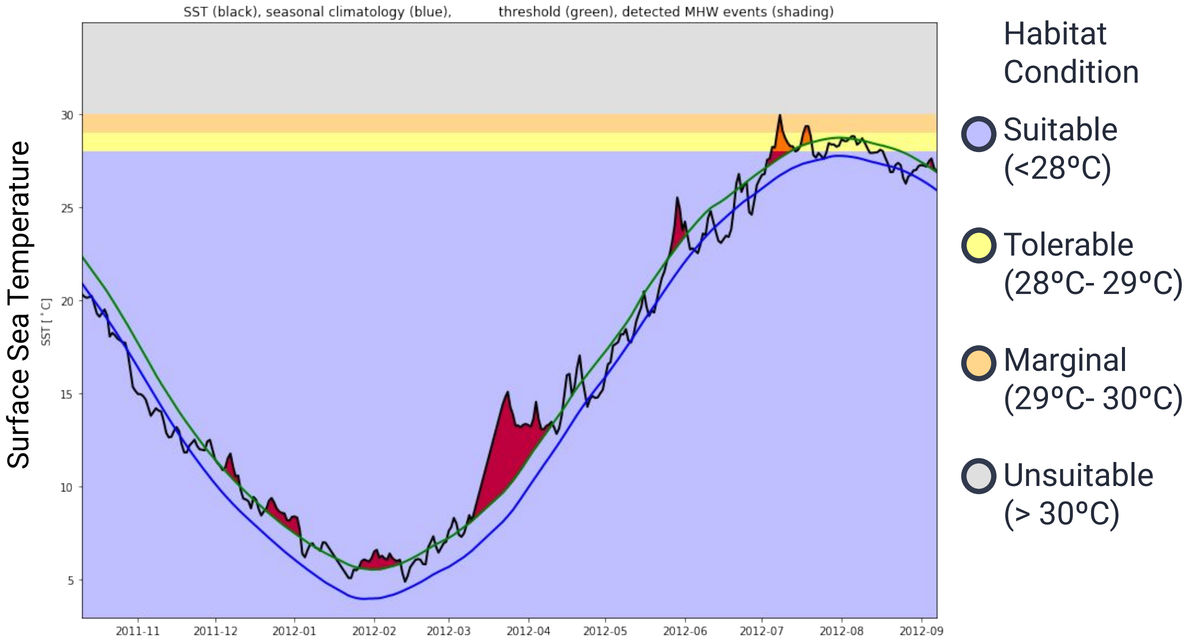


Integration of Living Resource and Marine Heatwave Information

- Identify and characterize marine heatwaves (e.g., intensity, duration, and frequency) related to living resource thresholds in seasonal summaries.
- Integrate marine heatwave information in communications to start raising awareness.
- Refine and make more robust as more data and research findings become available.

Example

Adult Striped Bass Habitat Condition Threshold



NOAA-Supported Monitoring and Living Resources Research

- Expanded Monitoring
  - New dissolved oxygen profilers and telemetry receiver platforms to collect long-term data on changes in environmental condition in the water column and fish habitat use of areas in Chesapeake Bay.
- NOAA Fisheries Research Program FY23 (ongoing research)
  - Forecasting the effects of climate change on Chesapeake Bay fisheries using physiologically informed habitat models (Fabrizio et al., VIMS)
  - Climate change and Striped Bass recruitment in the Choptank and Patuxent Rivers (Bi et al., UMCES)
  - Using time series analysis of linked rare events to quantify impacts of climate change on fish and shellfish in Chesapeake Bay (Nesslage and Lyubchich, UMCES)

GIT-Funded Collaborative Marsh Adaptation Project

(Nicole Carlozo, MDNR, Julie Reichert-Nguyen, NOAA)

Project Goals:

- Manage marshes to be **resilient** to sea level rise (SLR) and other climate change impacts to **preserve** ecosystem services.
- Identify **strategic large-scale** marsh adaptation projects that support **multiple benefits** instead of opportunistic, disconnected projects.
- Increase understanding of **geographical and organizational priorities** to build partnerships to support large-scale implementation.
- Align marsh resilience **research opportunities with implementation** to increase data and information on the **success** of strategies.
- Identify **short-term** and **long-term funding** opportunities.

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Marsh Adaptation Scenario Examples

Protection Scenario

Use data to identify ***healthy marshes*** that are susceptible to SLR and have the potential to migrate.

- Good Existing Marsh Condition
- High Climate Change Risk
- High Adaptive Capacity

Restoration and/or Enhancement Scenario

Use data to identify ***degraded marshes*** that are susceptible to SLR and have the potential to migrate.

- Degraded Existing Marsh Condition
- High Climate Change Risk
- High Adaptive Capacity

Based on the NOAA Landscape Scale Marsh Resilience Framework and Unvegetated to Vegetated Ratio (UVVR) decision matrix by USGS (Ganju et al. 2023)

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Broader-Scale Targeting

	Data Layers	Source
Existing Tidal Marsh	• Maryland Wetlands- estuarine and marine • Virginia Wetlands	• MD Wetland Inventory • VA Tidal Marsh Inventory
Marsh Health	Unvegetated to Vegetated Ratio (UVVR)	USGS Chesapeake Bay Coastal Wetlands Synthesis Datasets
Marsh Adaptive Capacity	• 2 and 4 ft SLR Marsh Migration Corridor Envelope (MMCE) • Developed lands/ Impervious Surfaces	• Marsh Migration Data Synthesis Report (Mitchell et al. 2023) - SLAMM, InVest, NOAA SLR • CBP Land Use
Protected Lands	MD and VA State Protected Lands	• MD Greenprint • VA Natural Heritage Data Explorer
State Targeted Priority Areas	• MD Targeted Ecological Areas • Conserve Virginia Map	• MD GreenPrint • VA Natural Heritage Data Explorer
Climate change Vulnerability	U.S. Sea Level Rise (SLR) – • Intermediate (2050) • Intermediate High (2050) • Intermediate (2090) • High (2090)	NOAA
Social Vulnerability	National Risk Index	FEMA
Partners	Areas of activity (currently engaged) Areas of interest/priority	Questionnaire, small group discussions

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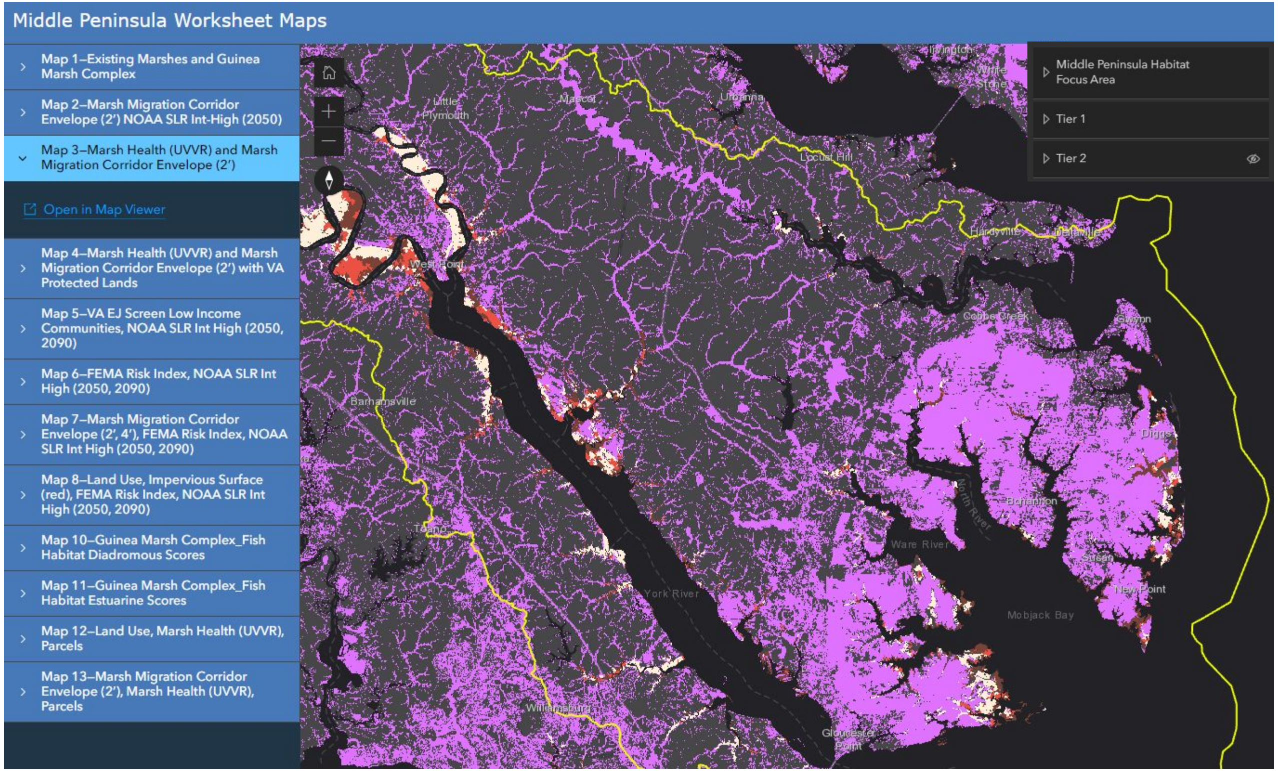
Interactive Story Maps of Data Overlays – Under Development

(John Wolf, USGS,
Julie Reichert-Nguyen,
Jamileh Soueidan)



Developing Marsh Adaptation Mapper with preset overlays to inform marsh adaptation considerations for targeting projects

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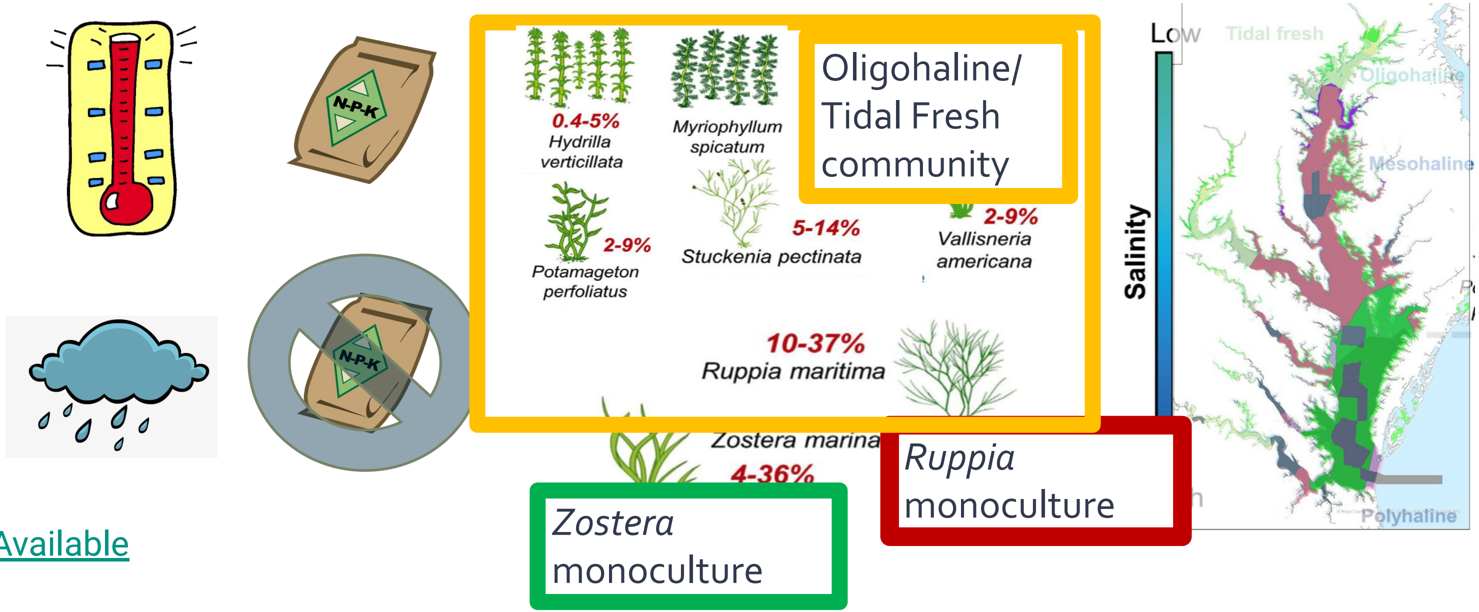
SAV Climate Modeling Synthesis GIT-Funded Project

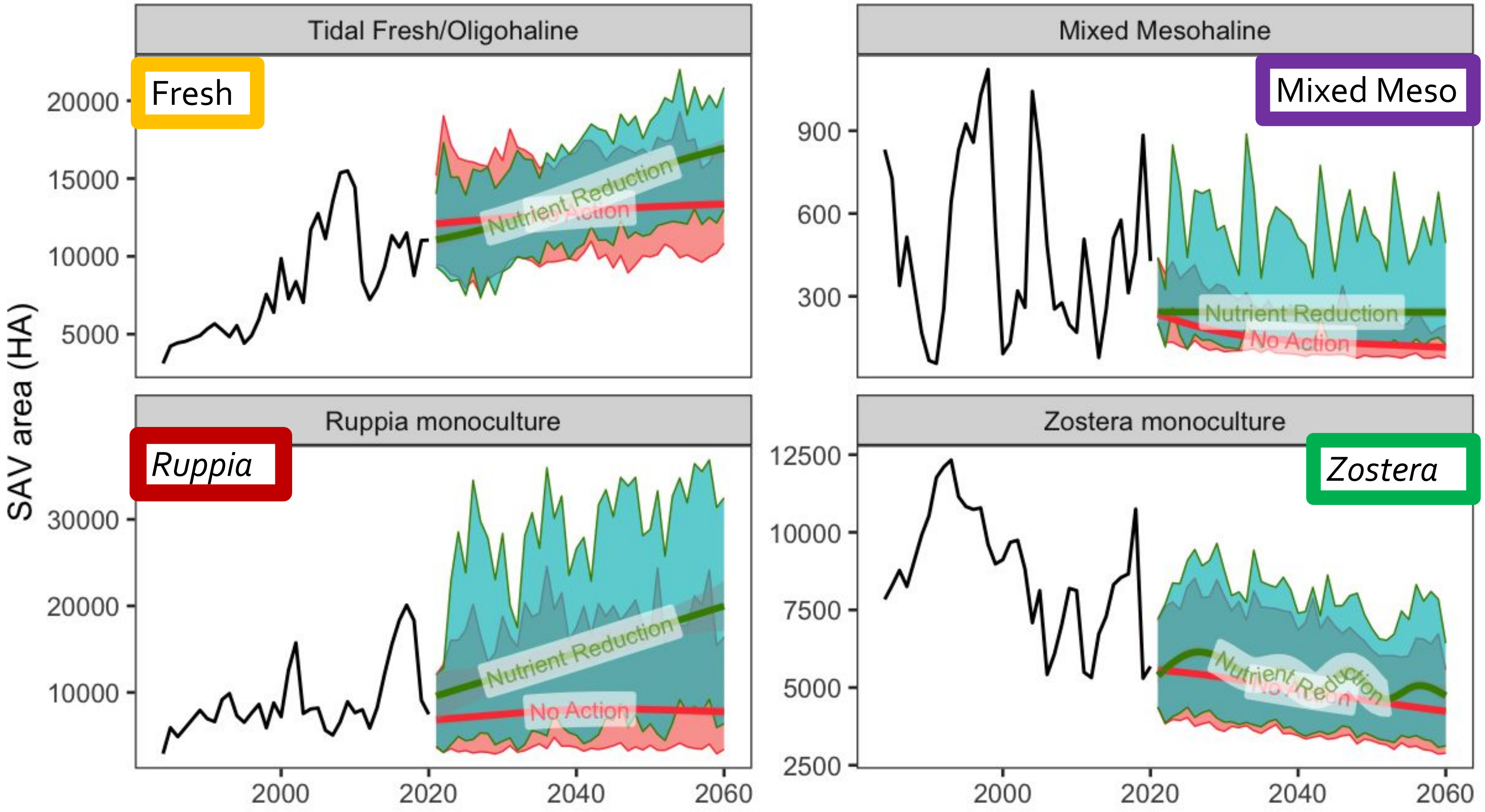
(SAV Workgroup - Brooke Landry, Marc Hensel, Chris Patrick, Dave Wilcox)

Project Goal: Determine how climate change and nutrient management affect major SAV communities in Chesapeake Bay; Tidal Fresh and Ruppia more dominant species under changing climate conditions



Report Available

New dominants respond most positively to nutrient reductions! 2021-2060 under climate change and nutrient management scenarios



SAV Climate Modeling Synthesis GIT-Funded Project Findings

- The models predicted that SAV will not reach its outcome without enhancements to the TMDL.
- Further N and P reductions will allow SAV to come closer to the outcome by 2060 (but still won't reach it).
- Eelgrass (*Zostera*) in the polyhaline will be the most heavily impacted because its a cold water plant.
- Widgeon Grass (*Ruppia*) more tolerable of the heat; responds quickly to WQ improvements.
- Increased temperatures are likely to impact freshwater and estuarine grasses in various ways like reproductive timing, germination timing, seasonality in general, but we don't know exactly how yet or the trophic impacts that will result.

Food for Thought

- Need more integration of temperature change and management scenarios to assess possible futures related to living resources response.
- Need improved living resources monitoring and modeling.
- There are many efforts assessing climate change effects on living resources - need to evaluate how to best integrate into TMDL climate model.
- Further discussion needed to connect living resources-related climate change research with Climate Model 3.0.
  - Afternoon Discussion Question: How can the CBP better incorporate living resources and landscape change into the Climate 3.0 workshop?

Season 11: Tackling Ecosystem-Level Impacts from Rising Water Temperatures

ccmp2024.chesapeake.org/#sessions

Thank you!

Please feel free to reach out at:

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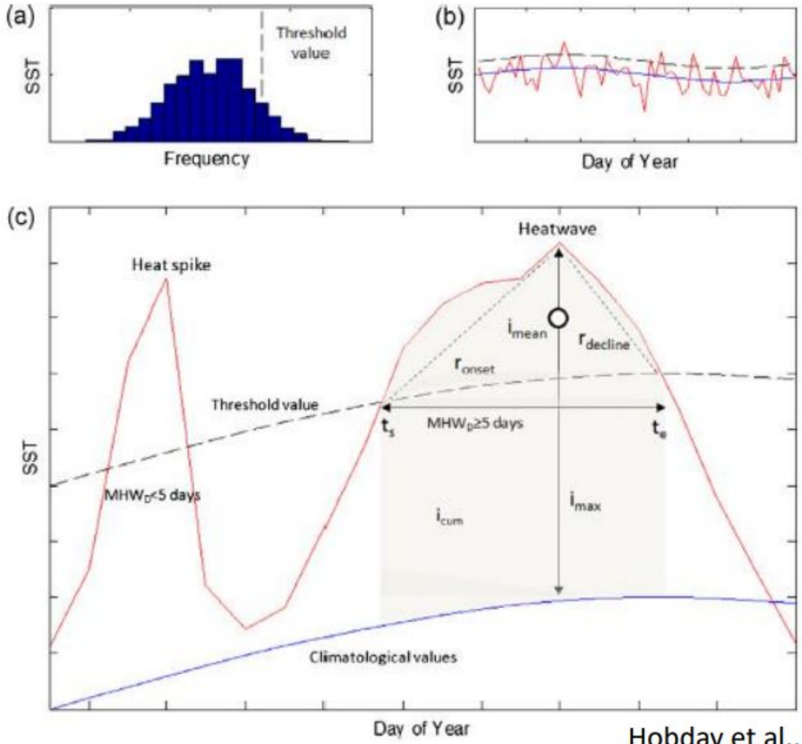
Common Definition in Scientific Literature (slide from Schunk et al. presentation)

MHW Definition
(Hobday et al., 2016)

"A **discrete prolonged anomalously warm** water event in a particular location"

- **Anomalously warm**:
  90th percentile above climatology
- **Prolonged**:
  Period of at least 5 days
- **Discrete**:
  2-day gap between two 5-day intervals



Hobday et al., 2016

Common Marine Heatwave Descriptive Characteristics

- Frequency: the number of marine heatwave events that occur every year.

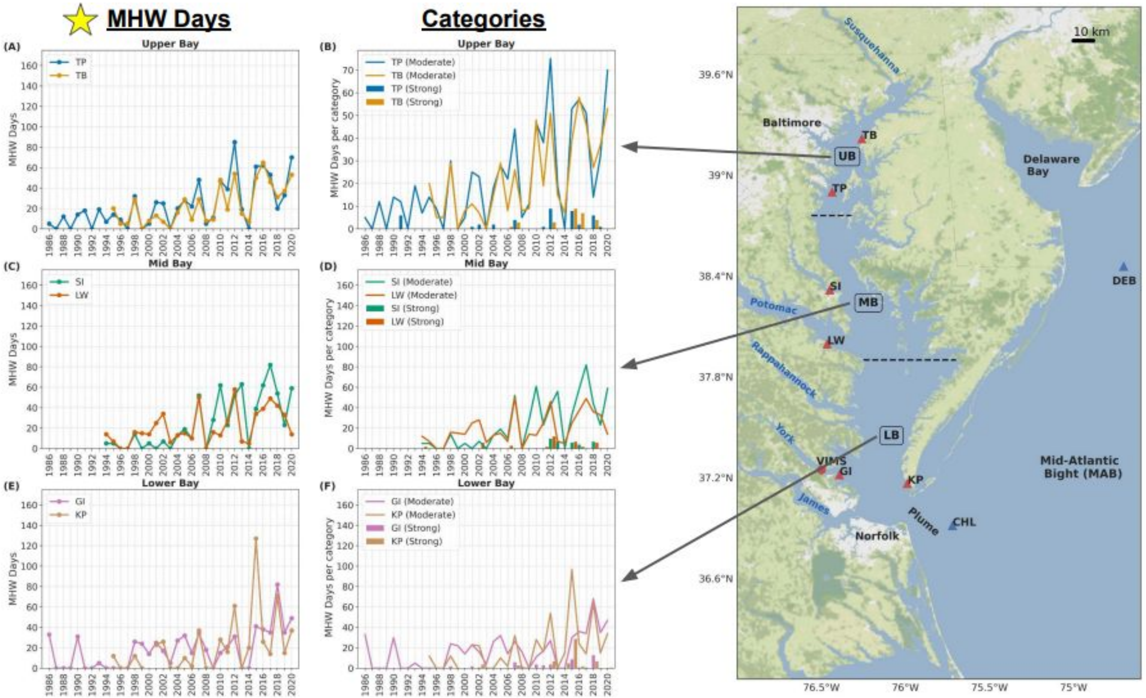
- Duration: the length of each individual marine heatwave, in days.

- Intensity: how hot it is during the marine heatwave event (expressed as the maximum or average)

- Cumulative Intensity: Integral of marine heatwave intensities over a time period (℃ x days) – combines magnitude and duration of heat anomalies
    - Good indicator of thermal stress to ecosystem

Chesapeake Bay Marine Heatwave (MHW) Research: In situ data (Mazzini & Pianca 2022)

- Significant long-term trends (1986-2020) were detected for MHW frequency, MHW days, and yearly cumulative intensity
- If trends persist, by the end of the century the Chesapeake Bay will reach a semi-permanent MHW state, when extreme temperatures will be present over half of the year.



Chesapeake Bay Marine Heatwave Research: Satellite data (Wegener 2022)

- Almost entire Bay has significant increases in the number of annual marine heatwave events (2002-2020).
- Spatial structure indicates marine heatwave cumulative intensity driven by increases in duration (not max intensity).
- Marine heatwave characteristic maps show significant spatial variation.
- Satellite analysis consistent with buoy-wide analysis.