RISING TEMPERATURES AND CHESAPEAKE BAY

WORKSHOP PURPOSE

1. Summarize major findings on the ecological impacts of rising water temperatures, including science-based linkages between causes and effects
2. Develop recommendations on how to mitigate these impacts through existing management instruments, ranging from developing indicators, identifying best management practices, and adapting policies.

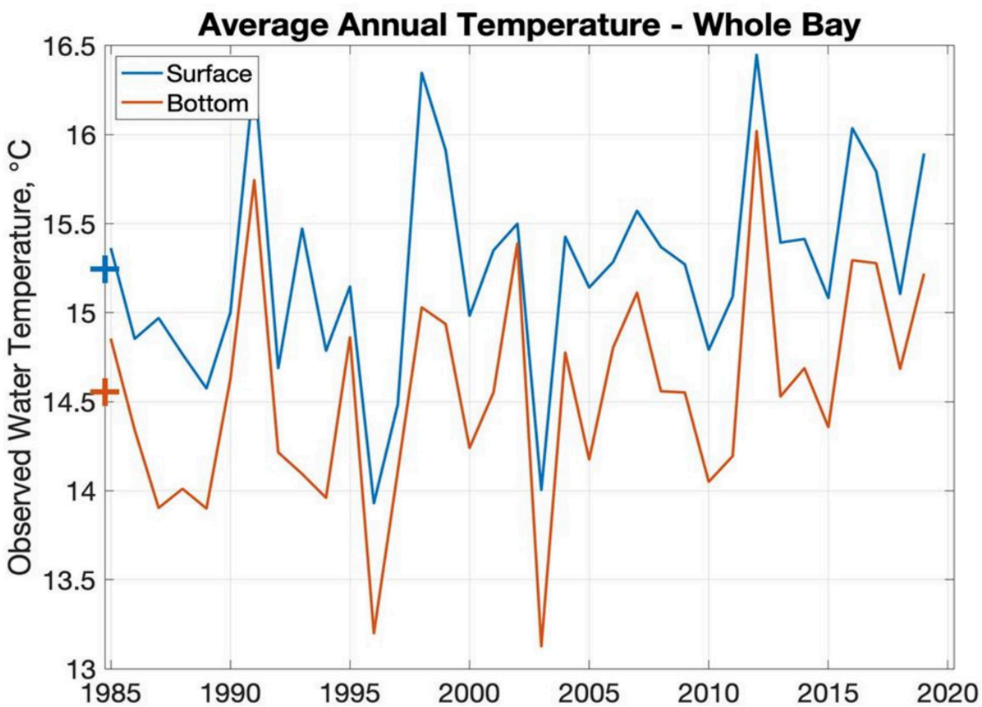
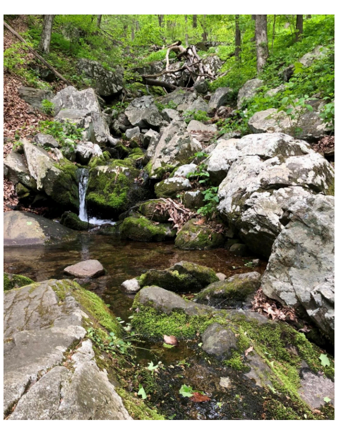


Figure 1. Temperature change over time in the Chesapeake Bay.

Water temperature increases are occurring in Chesapeake Bay tidal waters and in streams and rivers across the Bay's watershed, and are expected to continue. Water temperature increases have significant ecological implications for Bay and watershed natural resources, and could undermine progress toward Chesapeake Bay Program (CBP) Partnership goals for fisheries management, habitat restoration, water quality improvements, and protecting healthy watersheds. There is a critical need for insights into what the CBP Partnership might do now–within the scope of its current goals, policies and programs–to actively prevent, mitigate or adapt to some of the adverse consequences.




STREAM TEMPERATURES ARE RISING ACROSS THE CHESAPEAKE WATERSHED

Across the Chesapeake Bay watershed, stream temperature increased from 1960–2014 (Fig 2). Climate has the strongest influence on stream temperature. Water temperature increases more quickly than air temperature in agricultural areas without major dams. Water temperature increases slower in forested sites and in areas influenced by dams upstream. Increases in water temperature occurred at the greatest rates in the southern part of the watershed.

The impacts of increased stream temperature included increased biological processes and metabolism and reduced dissolved oxygen. Warming can also shift species distributions, causing increases in invasive species and pathogens.

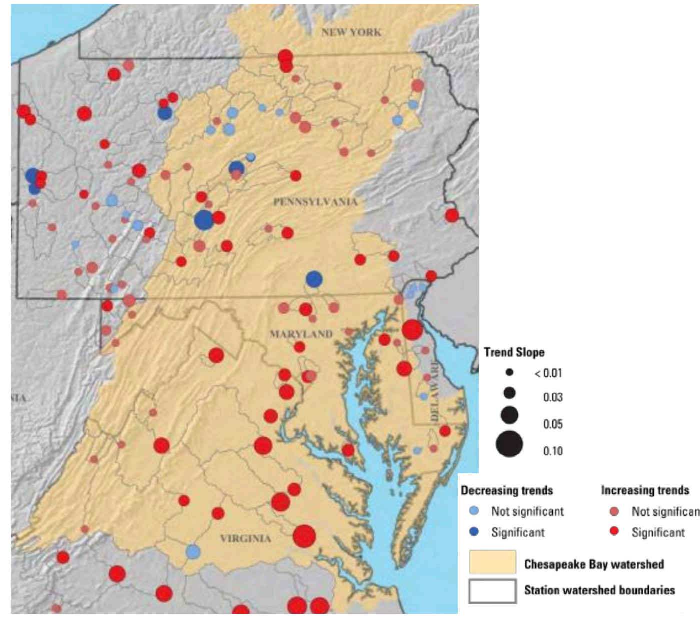


Figure 2. Locations of stream-water temperature measurement stations and temperature trends at those stations, 1960–2014.

WEB TOOLS ARE AVAILABLE TO ASSESS HABITAT HEALTH

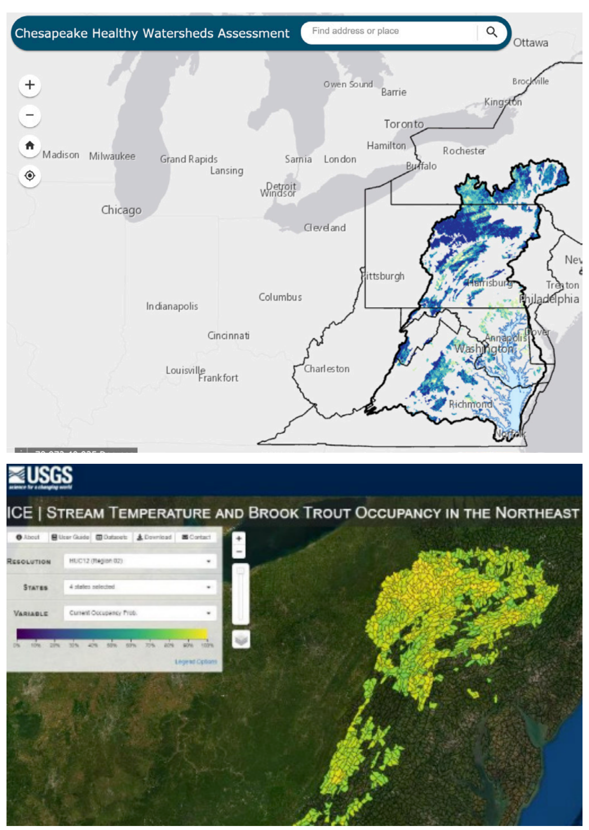


Figure 3. The Chesapeake Healthy Watersheds Assessment and the Interactive Catchment Explorer are interactive online tools to examine stream and watershed health.

TEMPERATURE-SENSITIVE SPECIES LIVE IN SMALL STREAMS

Current stream temperature modeling occurs across the watershed, but only in streams of a certain size. Many of the most temperature-sensitive species in the watershed live in small, shallow streams; too small to be captured by the current scale of modeling. Modeling stream temperature on a finer scale will provide better, more accurate predictions about impacts on temperature-sensitive species.

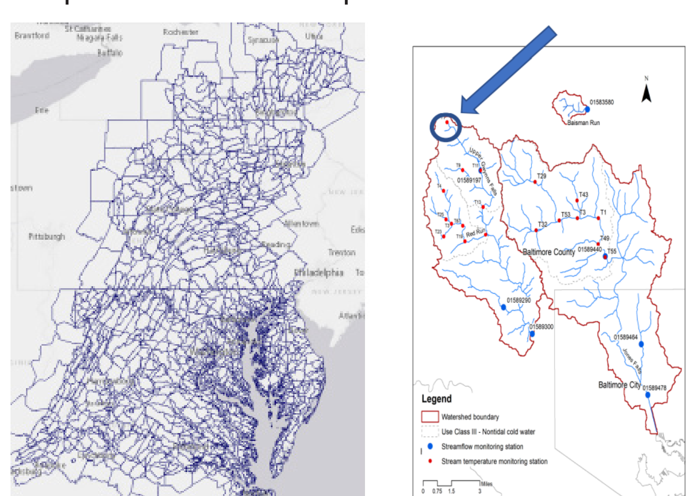


Figure 4. Spatial extent of stream temperature modeling in the Chesapeake watershed.

WATER TEMPERATURES IN THE CHESAPEAKE BAY ARE RISING

Temperatures are increasing across the Chesapeake Bay (+0.7°C per annum). Summer temperatures have increased more drastically (+1.0°C) than winter temperatures (0.3°C), especially at the mouth of the Bay.

The impacts of increased temperature include increased biological processes, reduced dissolved oxygen, increased mineralization rates, and increased water stratification. Rising temperatures will increase hypoxic volume due to dissolved oxygen solubility, increased biological rates, and increased stratification.

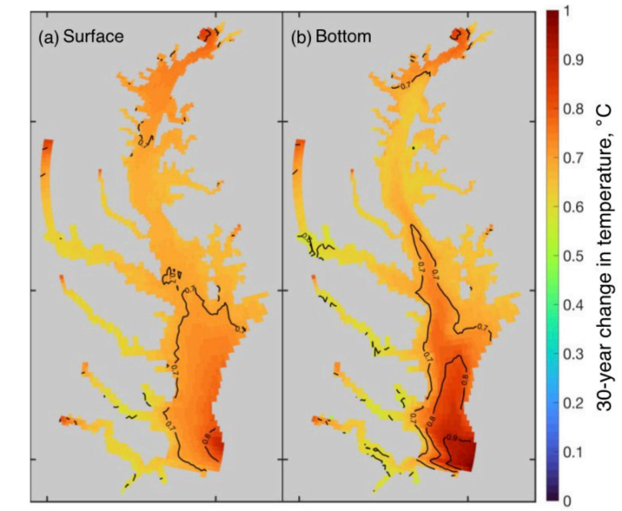
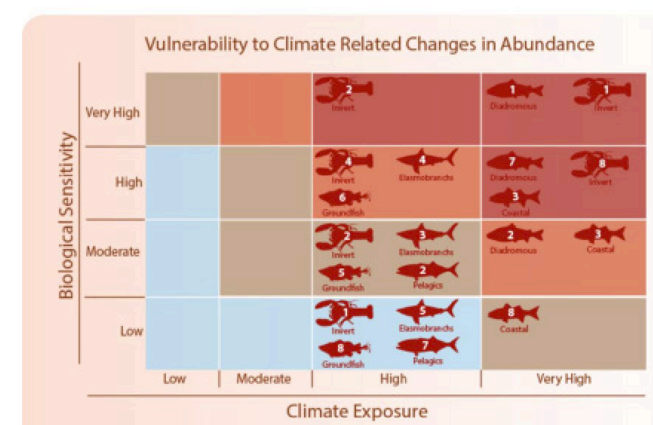
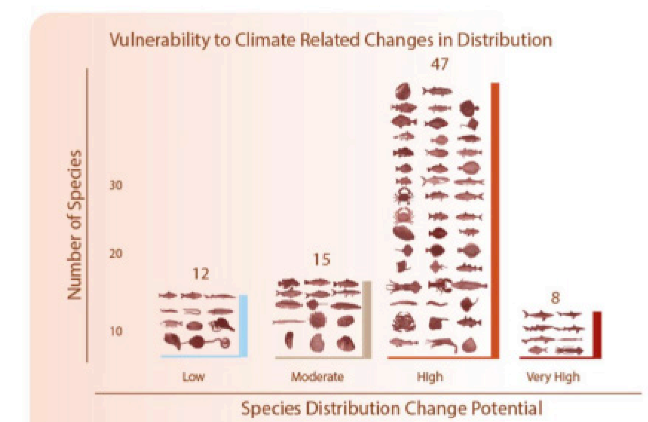


Figure 5. Chesapeake Bay water temperature change over time.

TEMPERATURE EFFECTS ON SPECIES VARY





INFLUENCES ON TEMPERATURE

Air temperature is the main driver influencing Bay water temperatures year-round, but effects are lessened during summer. Warming ocean boundary effects are important in summer, but small otherwise during the rest of the seasons. Sea level rise slightly cools the Bay's main stem from April to September and warms bottom waters in winter. River temperatures produce little to no warming in the Chesapeake Bay's main stetm. Increasing Bay water temperatures will result in increase volumes of low dissolved oxygen due to direct effects on oxygen solubility, biological process rates, and stratification.

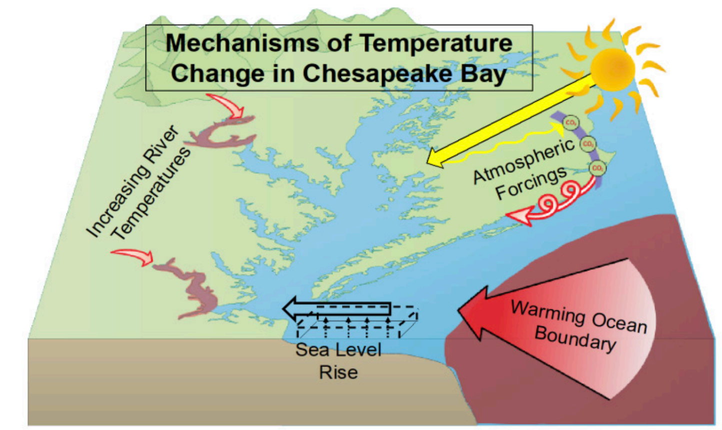


Figure 6. Mechanisms of temperature change in the Chesapeake Bay include atmospheric and ocean warming as well as river warming and sea level rise.

RESEARCH AND MANAGEMENT

Best management practices (BMPs) can mitigate the effects of temperature increase. Certain elements of urbanized ecosystems can be classified as heaters (like ponds), shaders (trees), and coolers (permeable pavement) in terms of water temperature. Stagnant water is more susceptible to heating, while water that slowly infiltrates the water table has more time to cool. Trees and forest prevent solar water heating. Stream heat models would enable further understanding of stream warming and the management practices that can prevent it.

SLOW IT DOWN, SHADE IT, SOAK IT IN

MONITORING

In the past 70 years, stream temperature data has been collected at 31,142 sites by multiple agencies across the Chesapeake Bay watershed. The U.S. Geological Survey has begun compiling data from multiple agencies for assessing status and trends of stream temperature across the Chesapeake Bay watershed. Some sites and agencies have more data than others. Compiling and understanding large datasets for stream temperature can inform understanding of factors that determine fish health, including temperature.

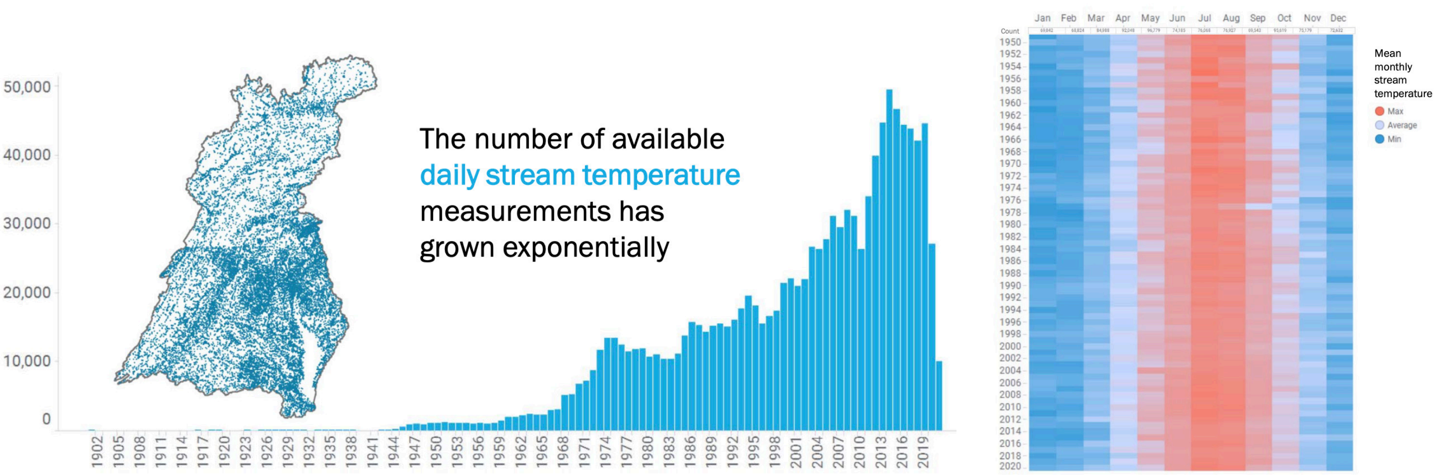


Figure 7. Available stream temperature data has increased over time (left), showing how average monthly temperatures change over time (right).

WORKSHOP STEERING COMMITTEE MEMBERS

Bill Dennison, co-chair, UMCES (Member, CBP STAC; and co-chair, CBP STAR Team); Rebecca Hanmer, co-chair (U.S. EPA, retired; Chair, CBP Forestry Workgroup); Rich Batiuk, U.S. EPA retired (CoastWise Partners); Frank Borsuk, U.S. EPA Freshwater Fisheries Biologist; Katherine Brownson, U.S. Forest Service; Matthew Ernhart, Stroud Water Research Center (Member, CBP Citizens Advisory Committee); Scott Phillips, USGS (co-chair, CBP Scientific, Technical Assessment, and Reporting Team); Julie Reichert-Nguyen, NOAA CBO (Coordinator, CBP Climate Resiliency Workgroup); Renee Thompson, USGS (Coordinator, CBP Healthy Watershed Goal Implementation Team); Bruce Vogt, NOAA CBO (Coordinator, CBP Sustainable Fisheries Goal Implementation Team).

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