Projecting the Future for Living Resources Under Changing Climate Conditions

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May 8, 2024

Outline

1. National Climate Assessment
2. The Future is now
3. Climate change stressors
4. Impacts on living resources
5. Improved science and management for adaptation and resilience

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National Climate Assessment

The ocean and coastal habitats in the Northeast are experiencing changes that are unprecedented in recorded history, including ocean warming, marine heatwaves, sea level rise, and ocean acidification *(high confidence)*. Changing ocean conditions are causing significant shifts in the distribution, productivity, and seasonal timing of life-cycle events of living marine resources in the Northeast *(high confidence)*. These impacts have spurred adaptation efforts such as coastal wetland restoration and changes in fishing behavior *(high confidence)*.

NCA 5

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The future is now

SIMONA CLAUSNITZER
IN THE EYE OF THE STORM
(2020, LINOCUT PRINT)

RITIKA S.
YOUTH ENTRY, GRADE 8
REDRAWING THE EARTH

NCA 5

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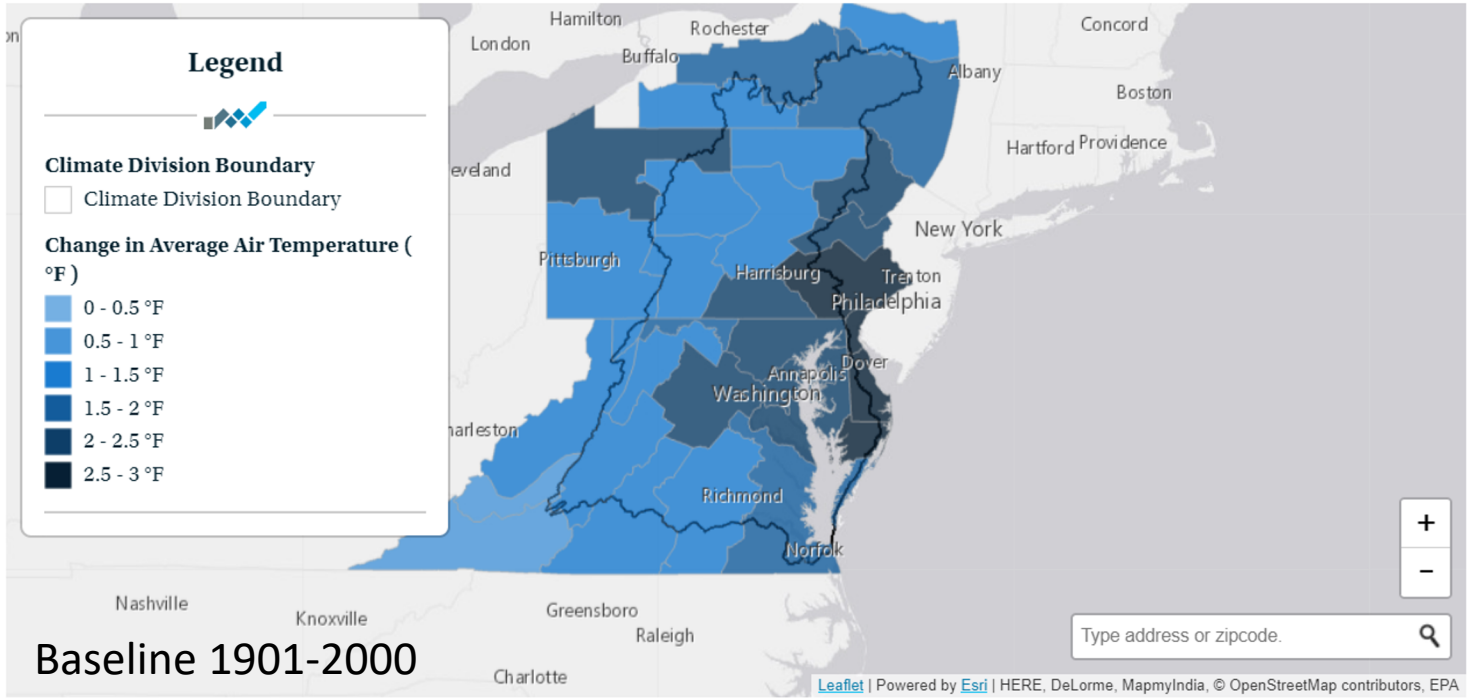
Chesapeake Bay – Air Temperature Trends

Average Air Temperature Increases in the Chesapeake Bay Watershed (1901-2021)



Baseline 1901-2000

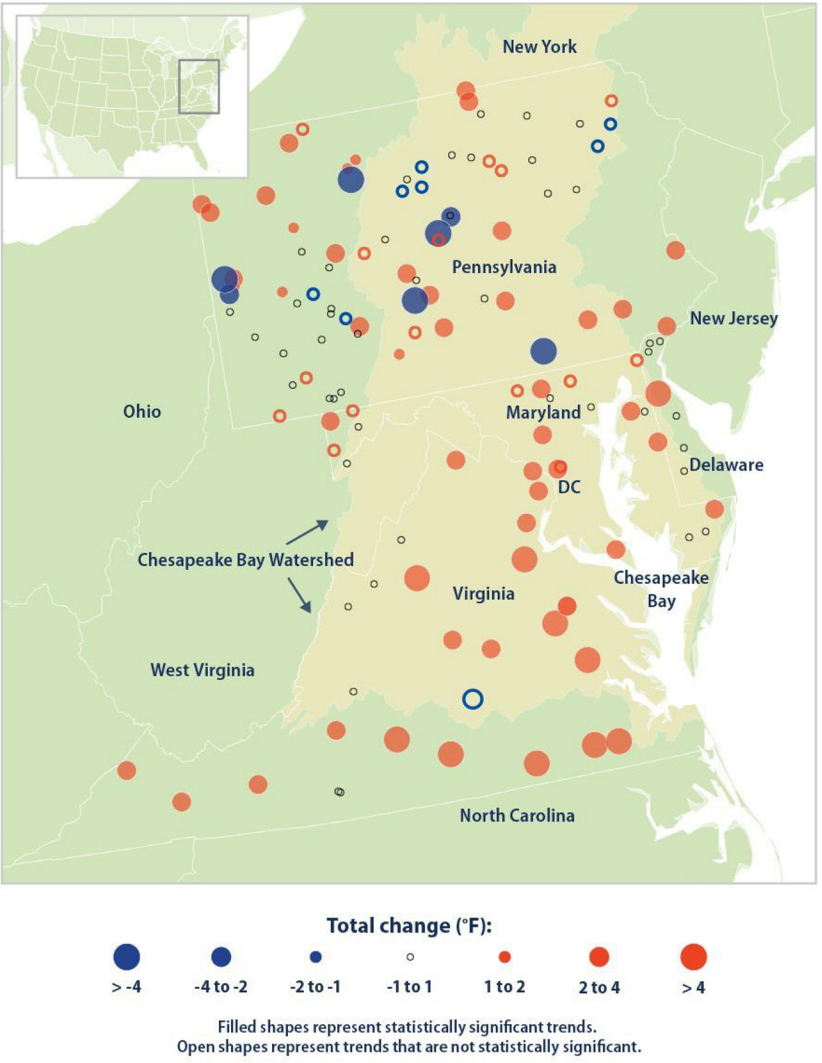
Present (2021):

Increases ranging from 0.6 to more than 2.8 degrees per century

www.chesapeakeprogress.com/climate-change/climate-monitoring-and-assessment

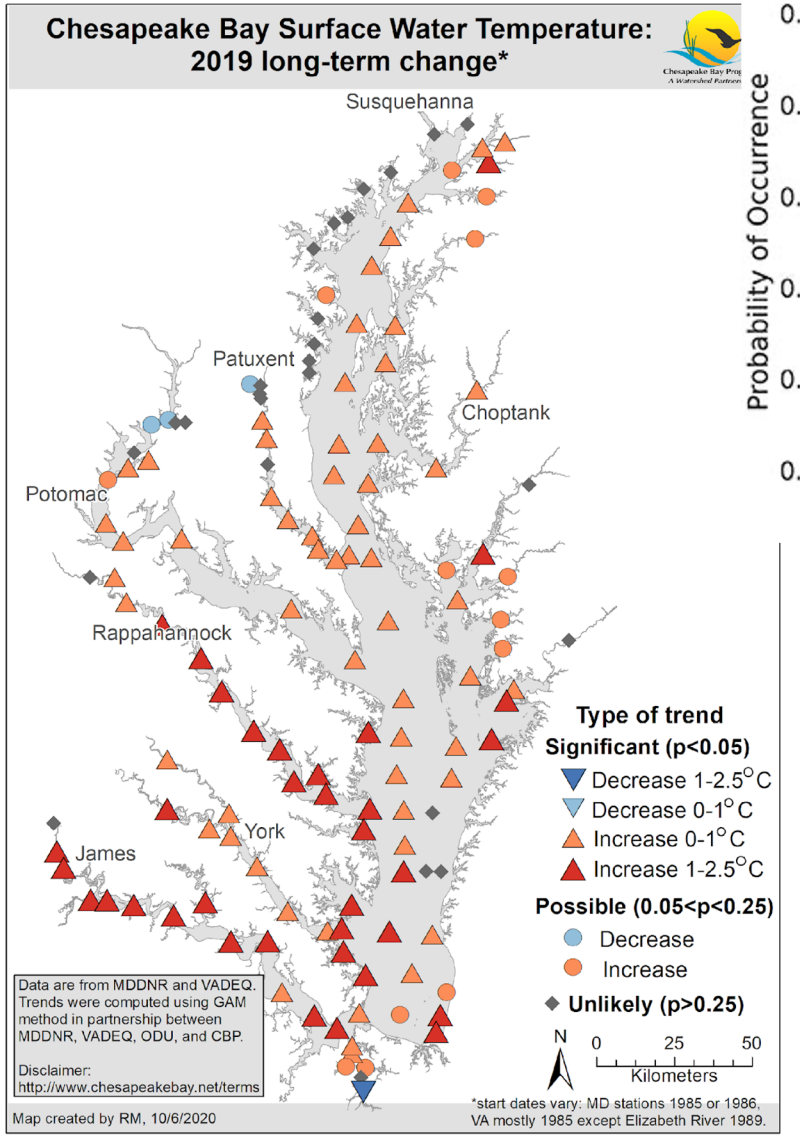
Challenge: Rising Water Temperatures

Warmer Watershed

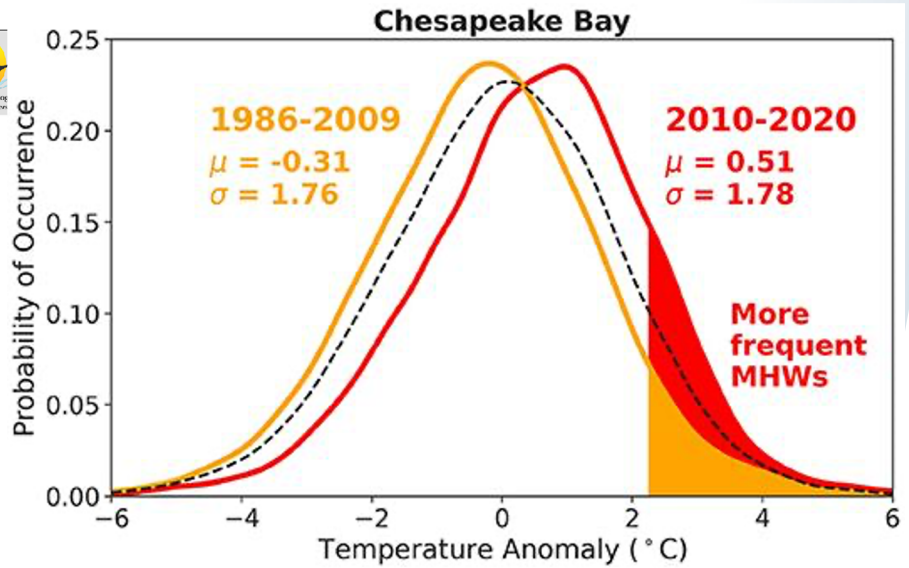


Rice and Jastram, 2015

Warmer Bay



Marine Heatwaves



Mazzini and Pianca 2022

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.

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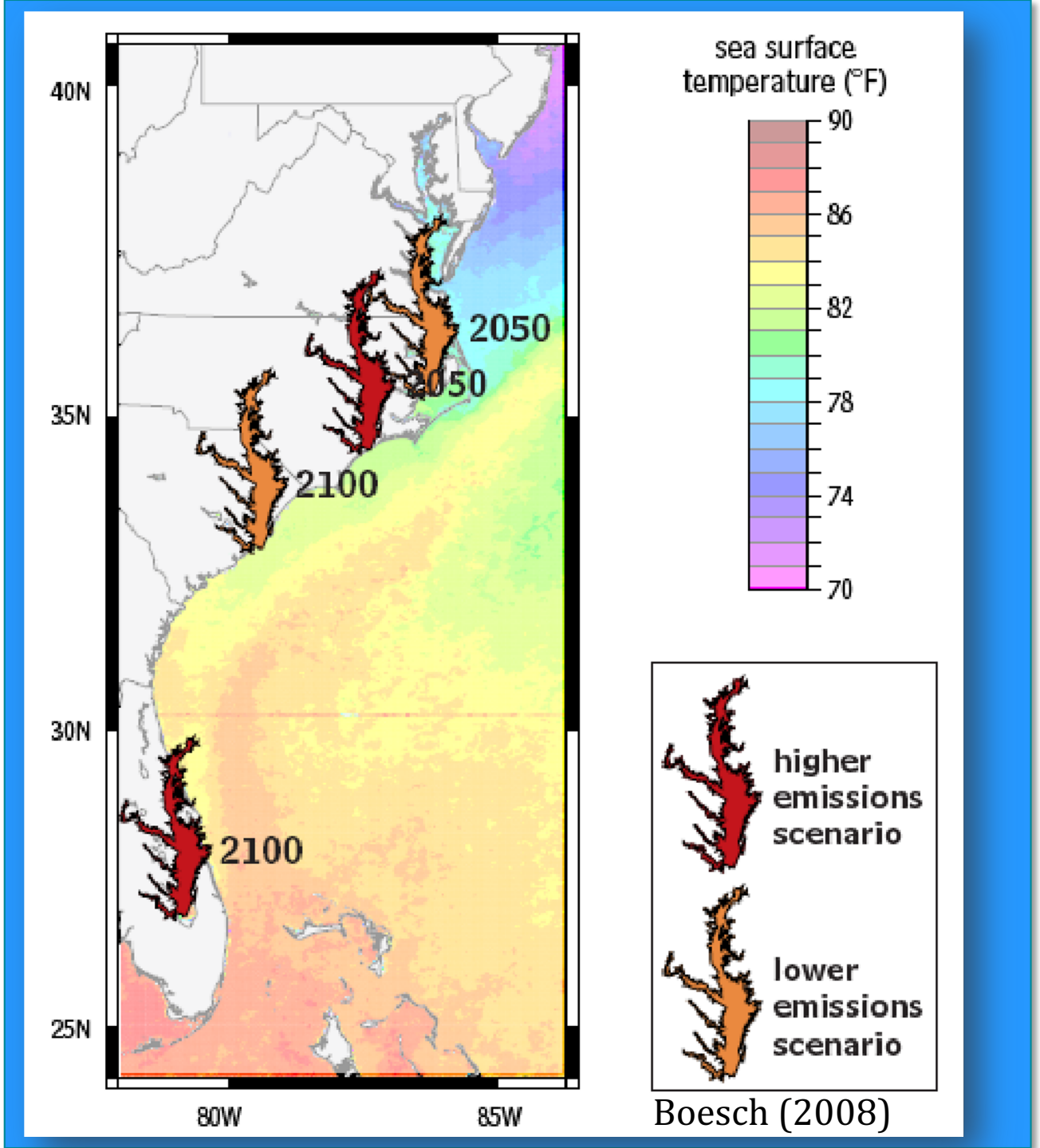

Boesch (2008)

A range of possibilities!

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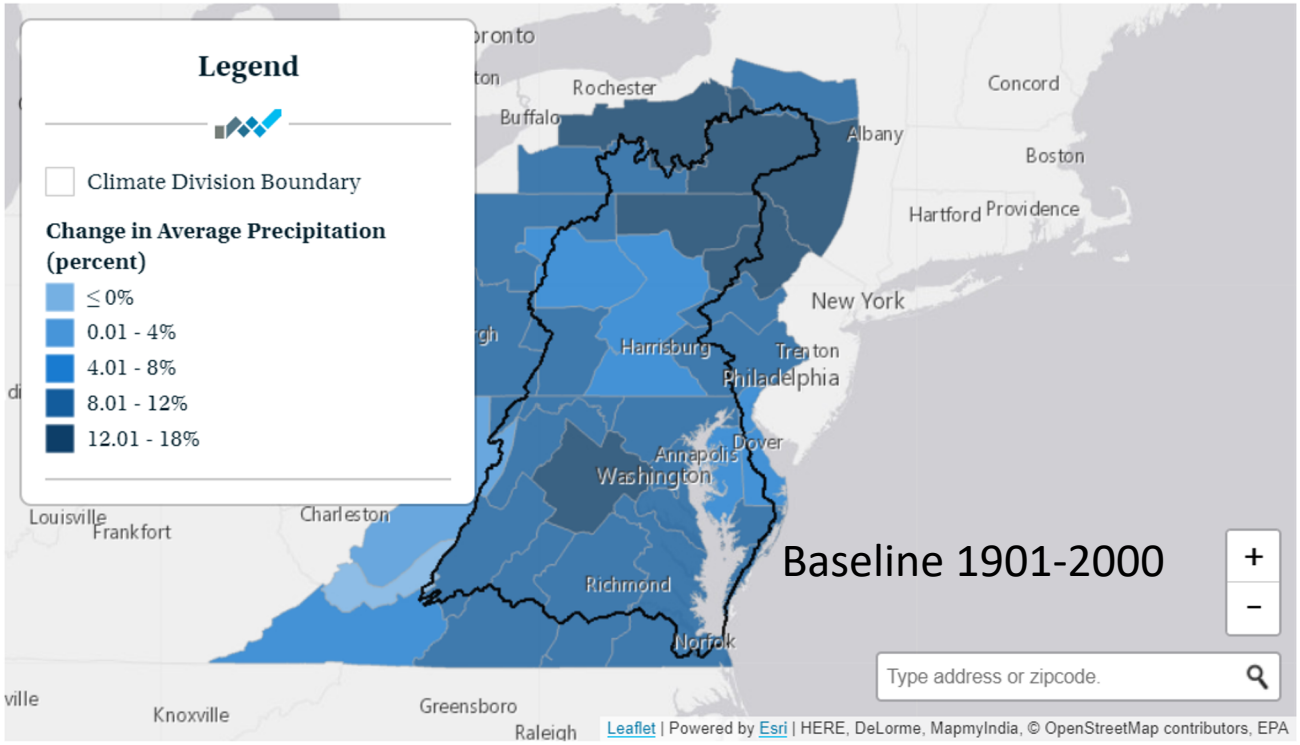
Chesapeake Bay – Precipitation Trends

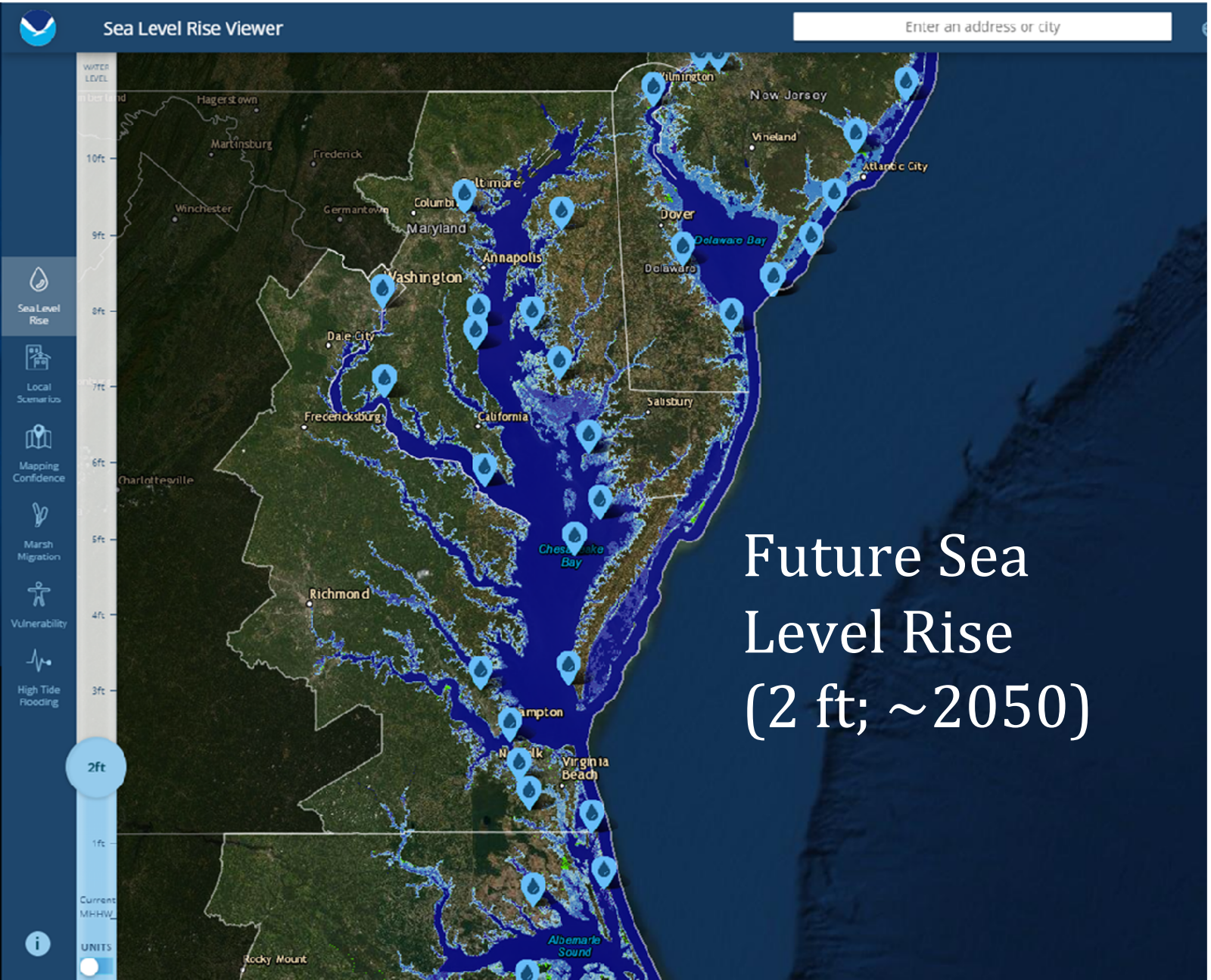
Present (2021):

Percent changes in total annual precipitation from the 100 year baseline range from a -0.203% decrease in southern West Virginia to a 17.62% increase in central New York



www.chesapeakeprogress.com/climate-change/climate-monitoring-and-assessment

Sea Level



Future Sea Level Rise (2 ft; ~2050)

Current Trend (1960-2017)

Sea levels have risen around 0.5-1 ft

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Ecological Impacts to Fish from Rising Water Temperatures:
Species-specific impacts

- **Positive impacts** are likely for blue crab as warmer temperatures support higher productivity and increased habitat range as species move northward.
- **Uncertain impacts** are predicted for oysters due to their already depressed populations as a result of disease, overfishing, and habitat loss.
- Striped bass may experience **both negative and positive impacts** at different stages of life (larval to adult) and habitat use (rivers and estuaries to marine).

Northeast Fish and Shellfish Climate Vulnerability Assessment

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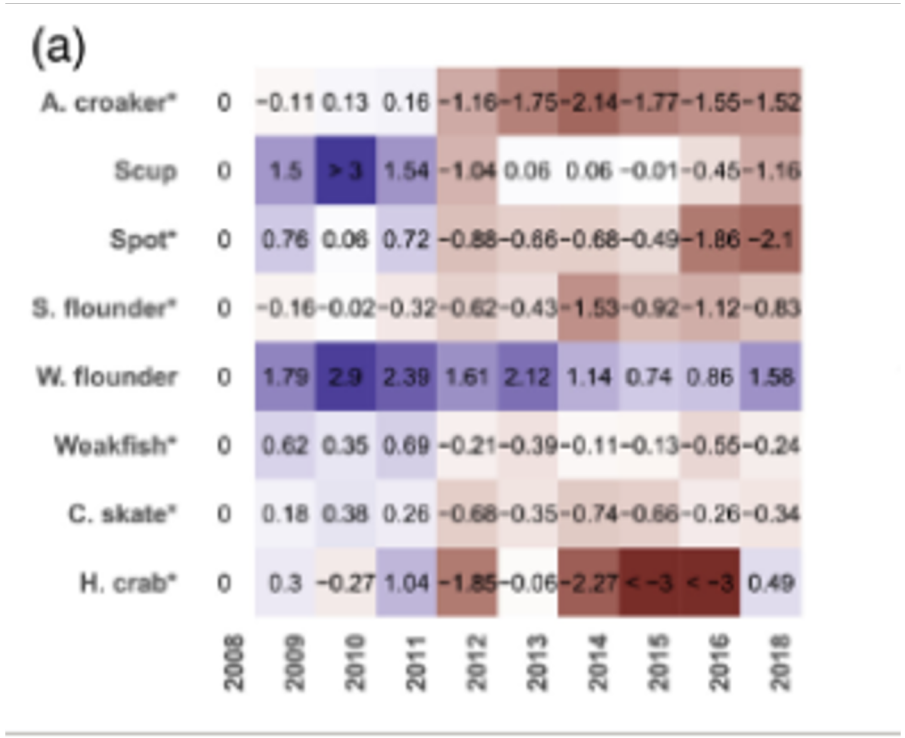
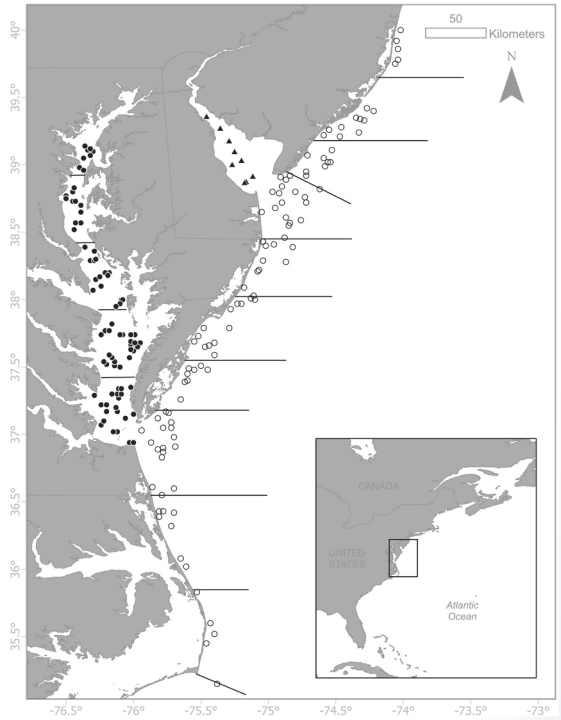
Changes in habitat usage for several species



Shonfeld et al, 2022. Fisheries Oceanography



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Cobia and Blue catfish

Red drum and Summer flounder

White shrimp

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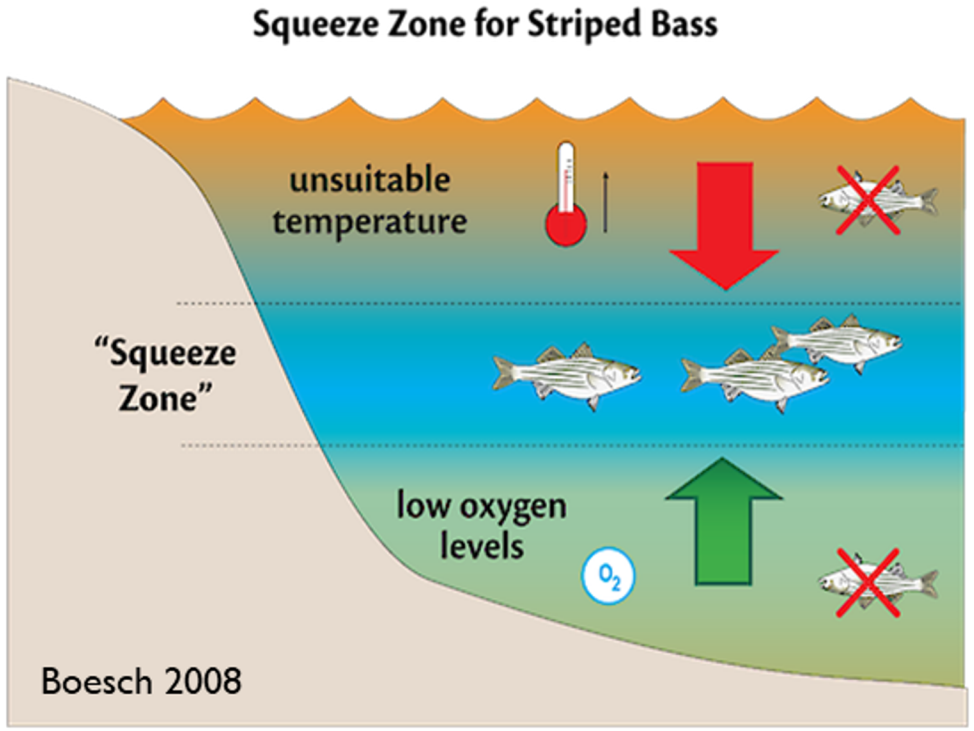
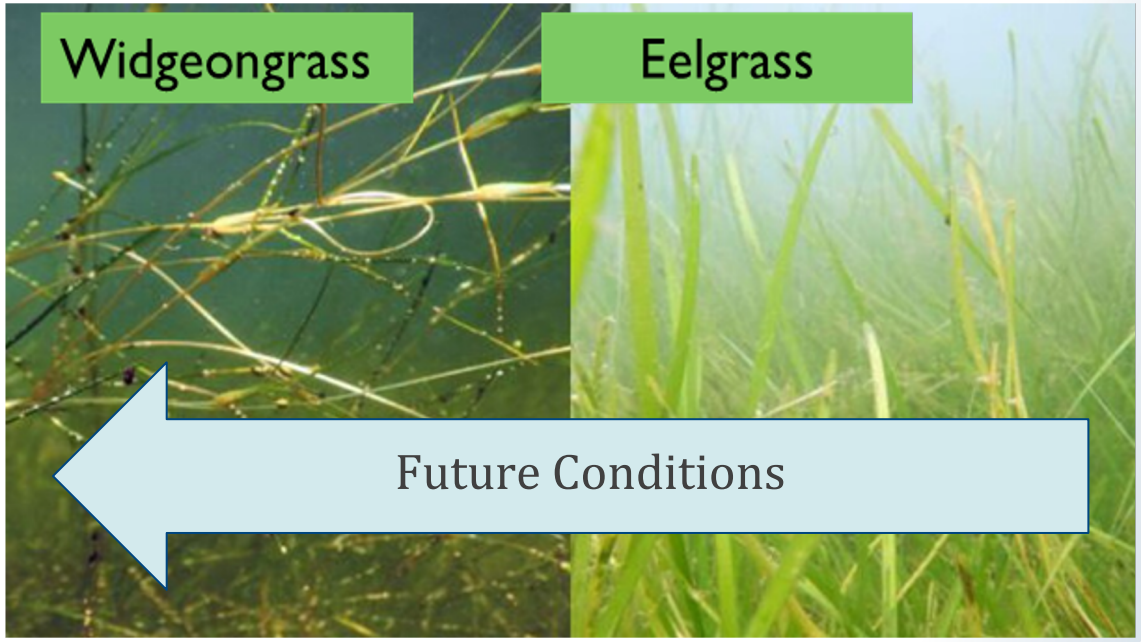
Impacts on Water Habitat & SAV





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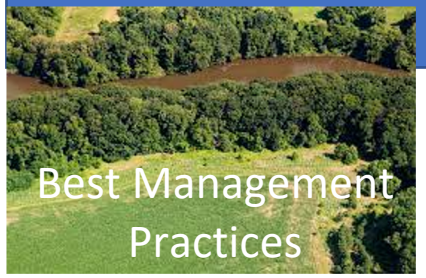
Impacts on Marshes

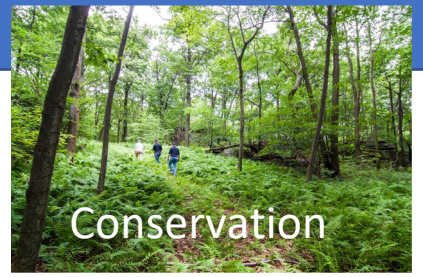
(© M. Kirwan/VIMS).

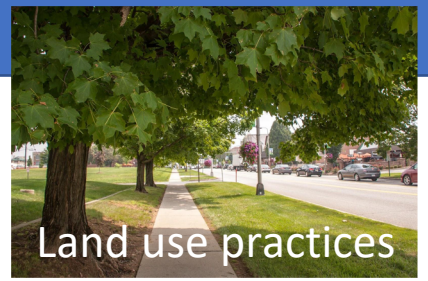
The future depends on our choices

Watershed

Mitigation - Lowering of Water Temps







Tidal

Adaptation - Minimize Impacts & Adjust

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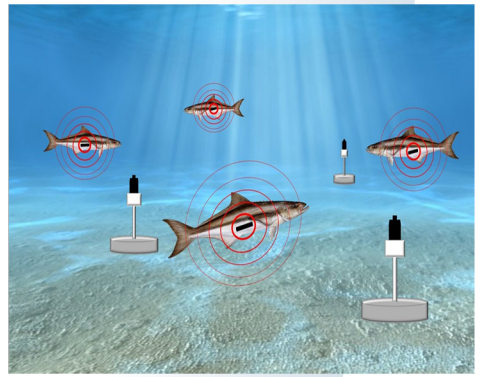
Science supports decision making



- Understand what is changing and mechanisms of change
- Employ new monitoring approaches
- Assess vulnerabilities and risk
- Track change and provide early warning
- Project future conditions (ecological forecasts)
- Establish climate informed reference points and/or thresholds
- Adaptive management responds to new information

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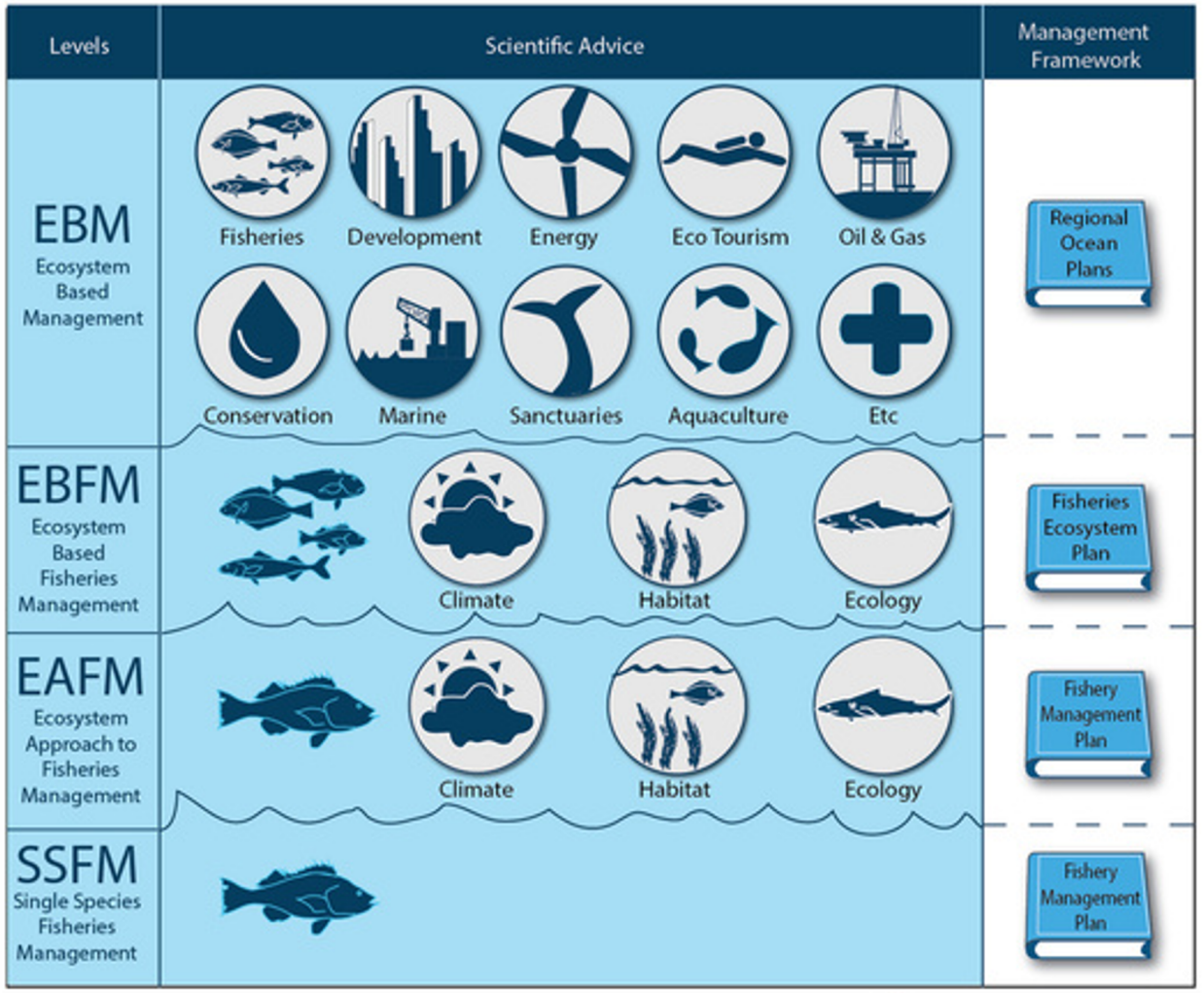
Alternative Management Frameworks

Ecosystem based management



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Ecosystem Status Reports and Risk Assessments

EAFM Risk Assessment: 2020 update

Species level risk elements

Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey	Climate	DistShift	EstHabitat
Ocean Quahog	lowest	lowest	lowest	lowest	lowest	lowest	highest	modhigh	lowest
Surfclam	lowest	lowest	lowest	lowest	lowest	lowest	modhigh	modhigh	lowest
Summer flounder	lowest	lowest	lowmod	lowest	lowest	lowest	lowmod	modhigh	highest
Scup	lowest	lowest	lowest	lowest	lowest	lowest	lowmod	modhigh	highest
Black sea bass	lowest	lowest	lowest	lowest	lowest	lowest	modhigh	modhigh	highest
Atl. mackerel	lowest	highest	highest	lowest	lowest	lowest	lowmod	modhigh	lowest
Butterfish	lowest	lowest	lowest	lowest	lowest	lowest	lowest	highest	lowest
Longfin squid	lowmod	lowmod	lowmod	lowest	lowest	lowmod	lowest	modhigh	lowest
Shortfin squid	lowmod	lowmod	lowmod	lowest	lowest	lowmod	lowest	highest	lowest
Golden tilefish	lowest	lowest	lowmod	lowest	lowest	lowest	modhigh	lowest	lowest
Blueline tilefish	highest	highest	modhigh	lowest	lowest	lowest	modhigh	lowest	lowest
Bluefish	lowest	lowest	highest	lowest	lowest	lowest	lowest	modhigh	highest
Spiny dogfish	lowmod	lowest	lowmod	lowest	lowest	lowest	lowest	highest	lowest
Monkfish	highest	lowmod	lowmod	lowest	lowest	lowest	lowest	modhigh	lowest
Unmanaged forage	na	na	na	lowest	lowmod	lowmod	na	na	na
Deepsea corals	na	na	na	lowest	lowest	lowest	na	na	na

Ecosystem level risk elements

System	EcoProd	CommRev	RecVal	FishRes1	FishRes4	FleetDiv	Social	ComFood	RecFood
Mid-Atlantic	lowmod	modhigh	highest	lowest	modhigh	lowest	lowmod	highest	modhigh

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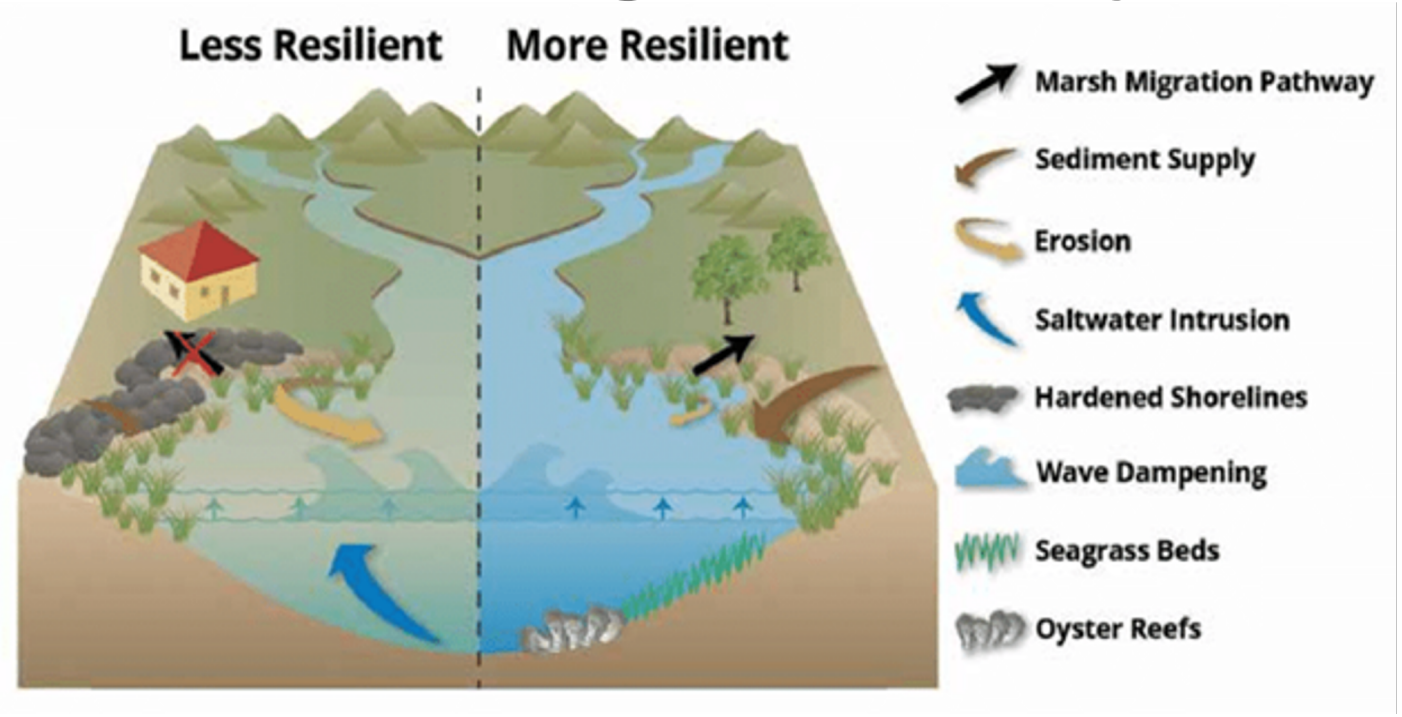
Building Resilience

A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment



Kister 2016 (Reprinted with permission from the Integration & Application Network, 2013)

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Questions?

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YOUTH ENTRY, GRADE 8

REDRAWING THE EARTH

Chesapeake Bay Program

Science. Restoration. Partnership.

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Backup

Identified Science Needs:
Ecosystem-Based Management—Monitoring

Photo: Doug Wilson

- Improve environmental monitoring of surface and bottom temperature, dissolved oxygen, and fish habitat condition.
- Consider establishing monitoring stations where there are significant fisheries habitat and spawning grounds.
- Evaluate needs for zooplankton monitoring at fish spawning and nursery areas to assess food web shifts.
- Explore the need for *in situ* monitoring of lower trophic organisms to better assess physiological response to changing conditions.

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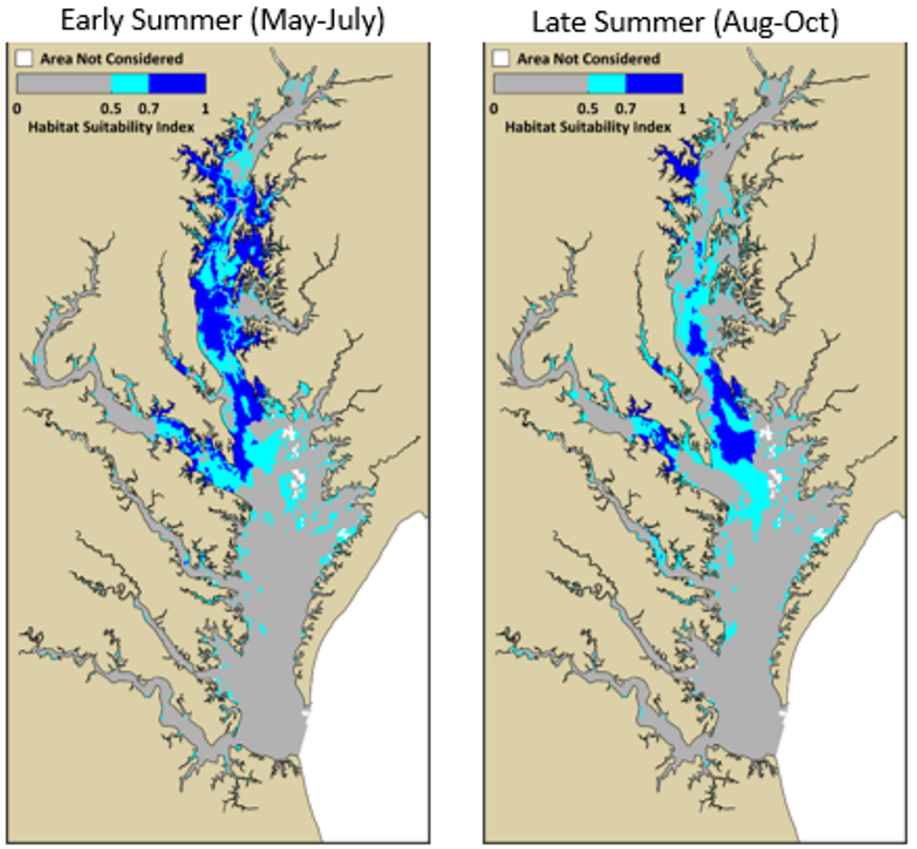
Identified Science Needs:

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.
- 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.
- Research how loss of late-winter/spring eelgrass habitat will affect blue crab populations.



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

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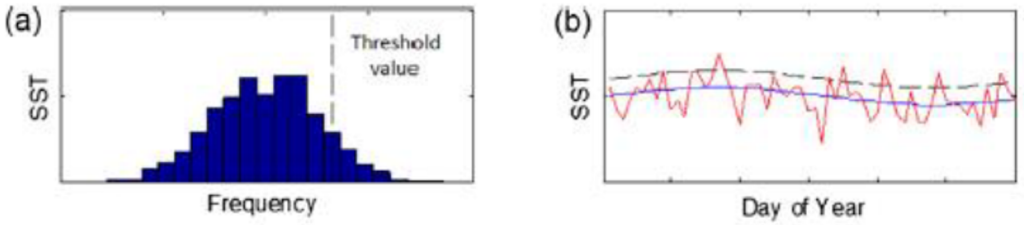
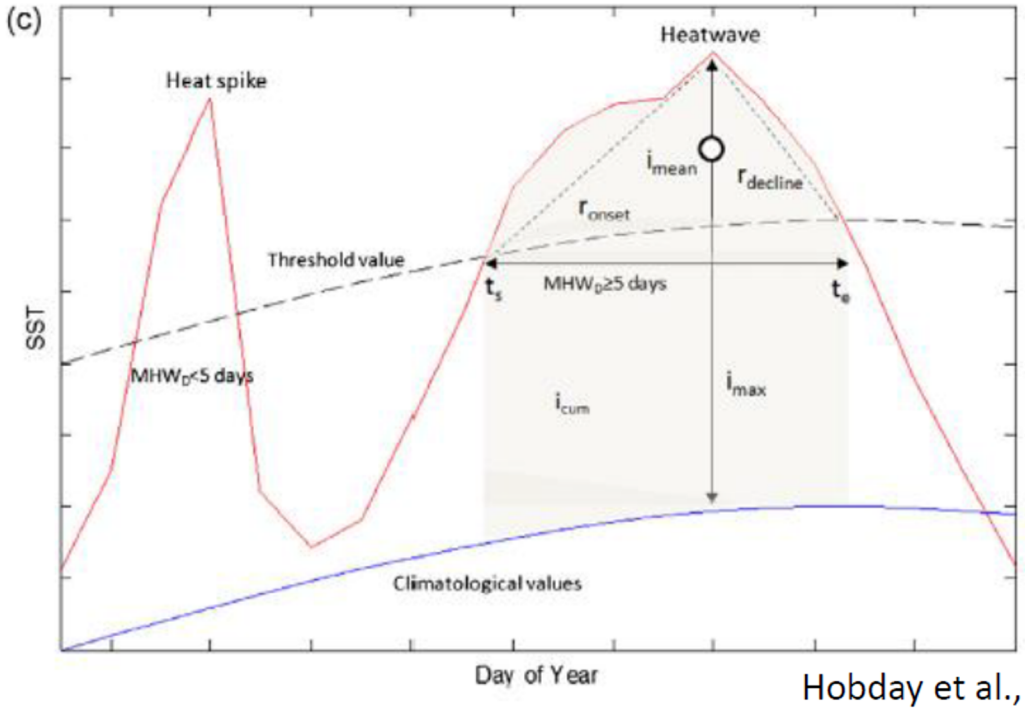
Identified Science Needs:

Extreme Climate Change Stressors—Marine Heat Waves





Hobday et al., 2016

- Relate current definitions of marine heat waves with living resource thresholds to determine an appropriate definition for Chesapeake Bay.
- Explore real time monitoring of marine heat waves and forecast products.
- Consider a marine heat wave indicator that connects with living resource management and guidance to the public.

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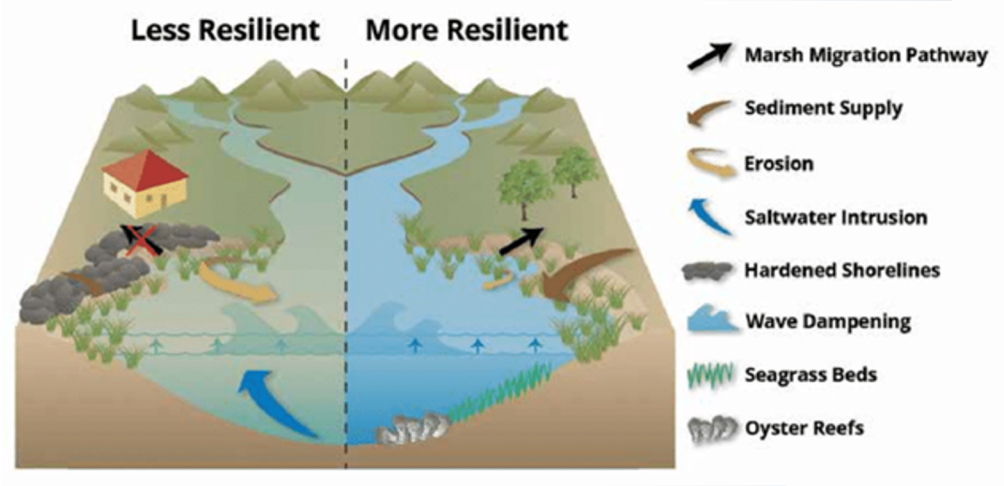
Identified Science Needs:

Nearshore Habitat—Strategic Restoration

- Support threshold analyses to determine when ecological impacts or benefits occur from natural infrastructure implementation.
- Develop criteria for targeting nearshore restoration where multiple benefits and ecosystem services can be optimized.
- Increase understanding of watershed practices that can reduce local warming effects.
- Use models to increase understanding of habitat change from sea level rise to inform restoration strategies.

Photo: Peter McGowan, USFWS



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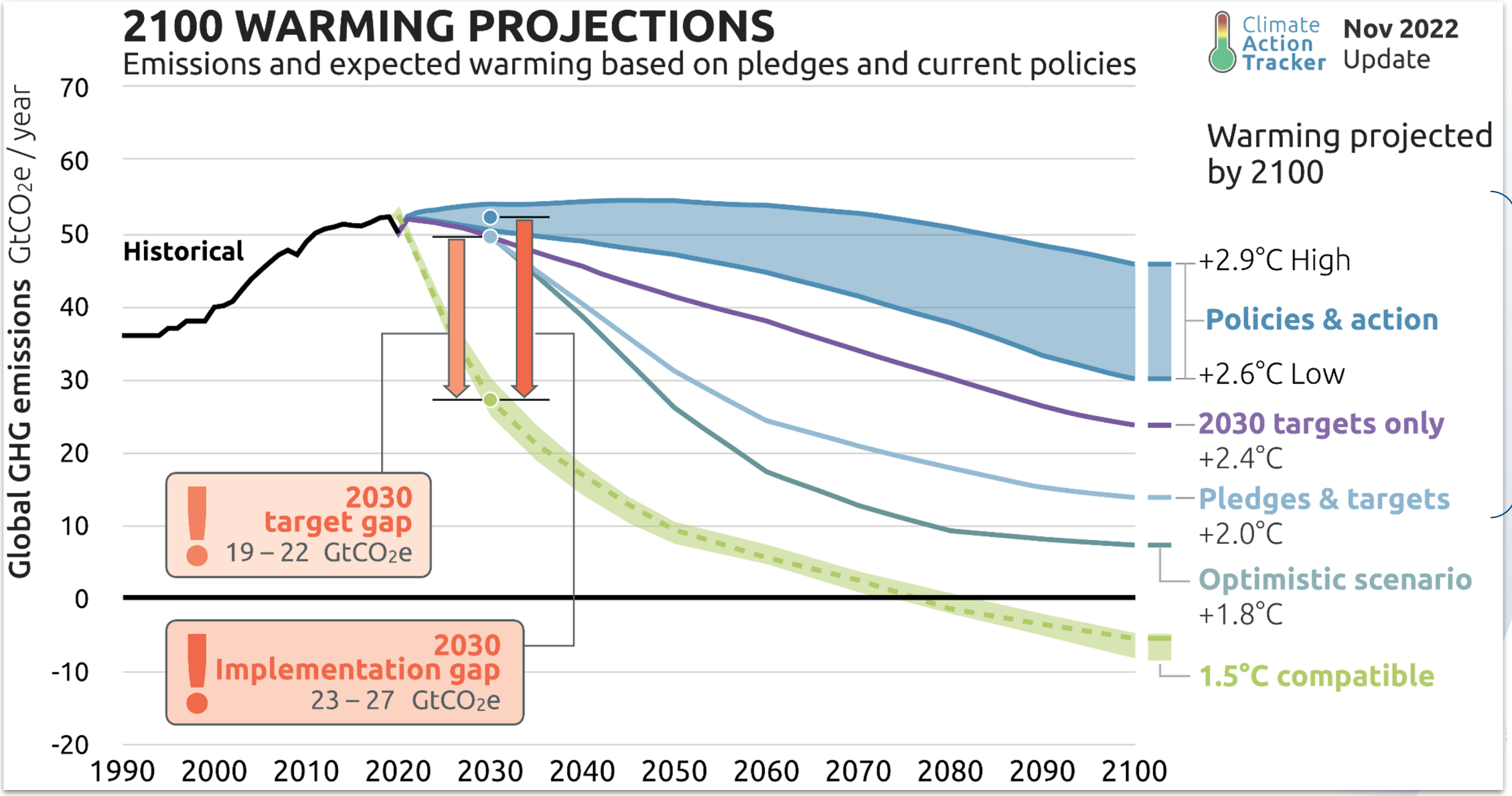
We are headed for dangerous temp. ranges by 2100



RCP 4.5
580-720 ppm CO_2;
2.1-3.5°C

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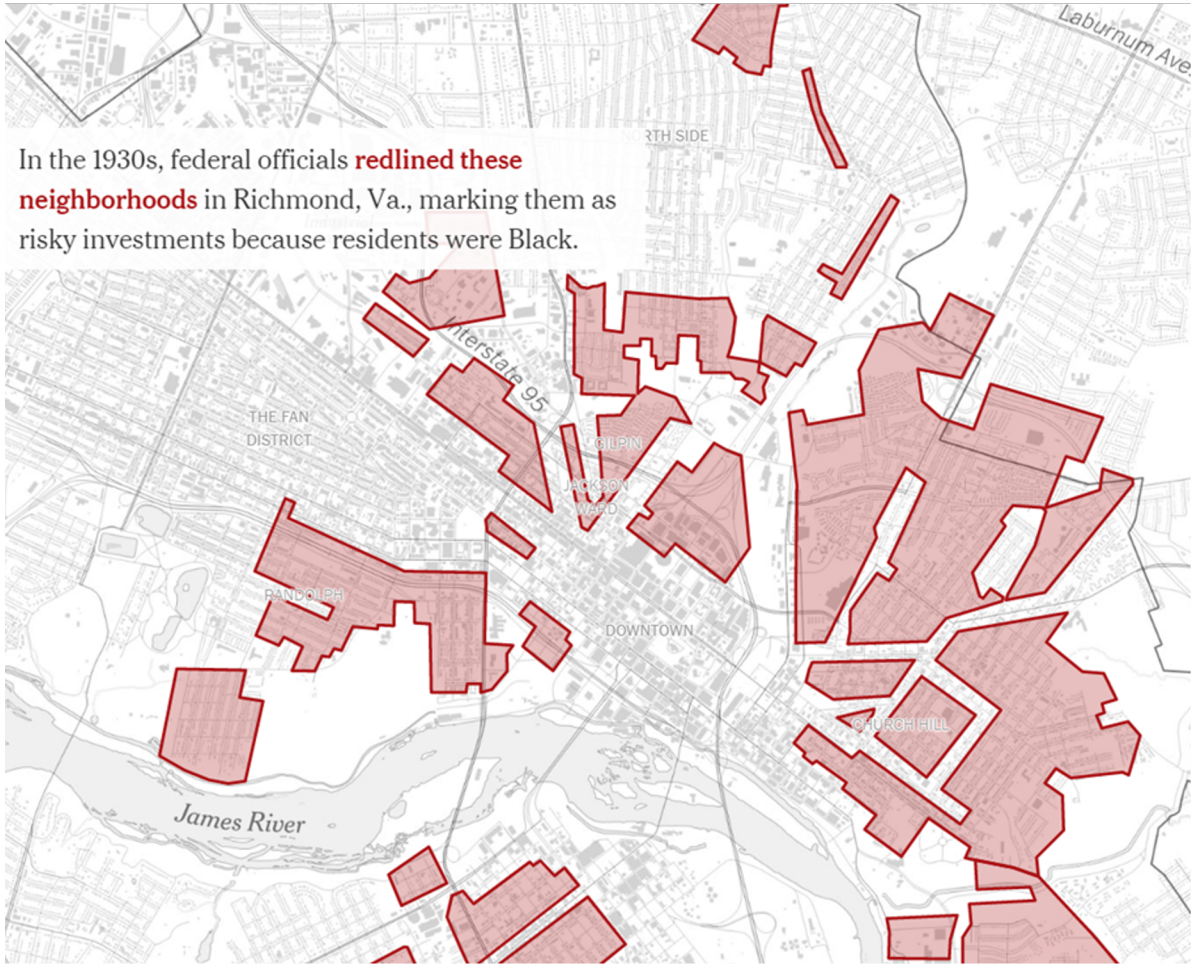
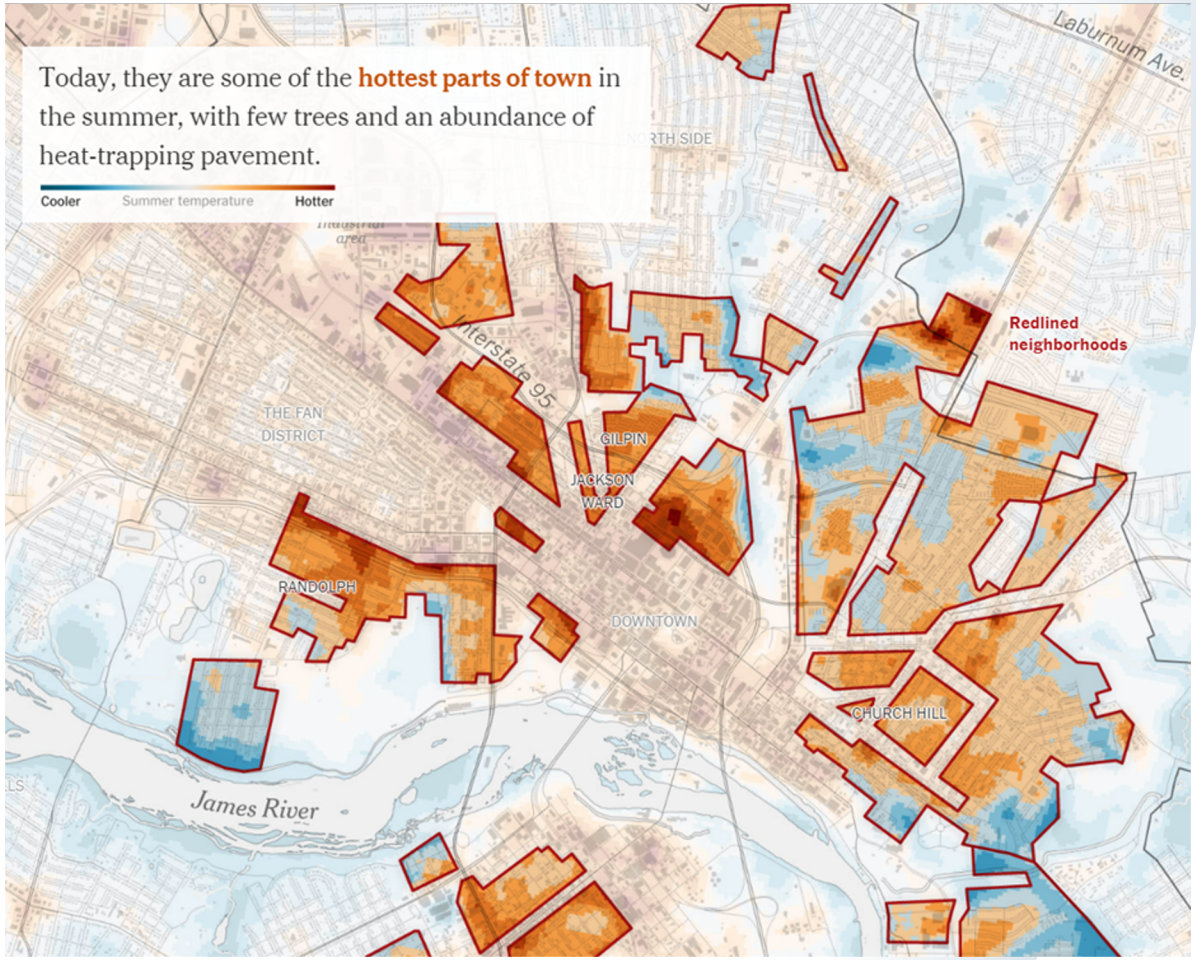
Climate impacts are not experienced equally





Source: New York Times, “How Decades of Racist Housing Policy Left Neighborhoods Sweltering,” August 24, 2020.

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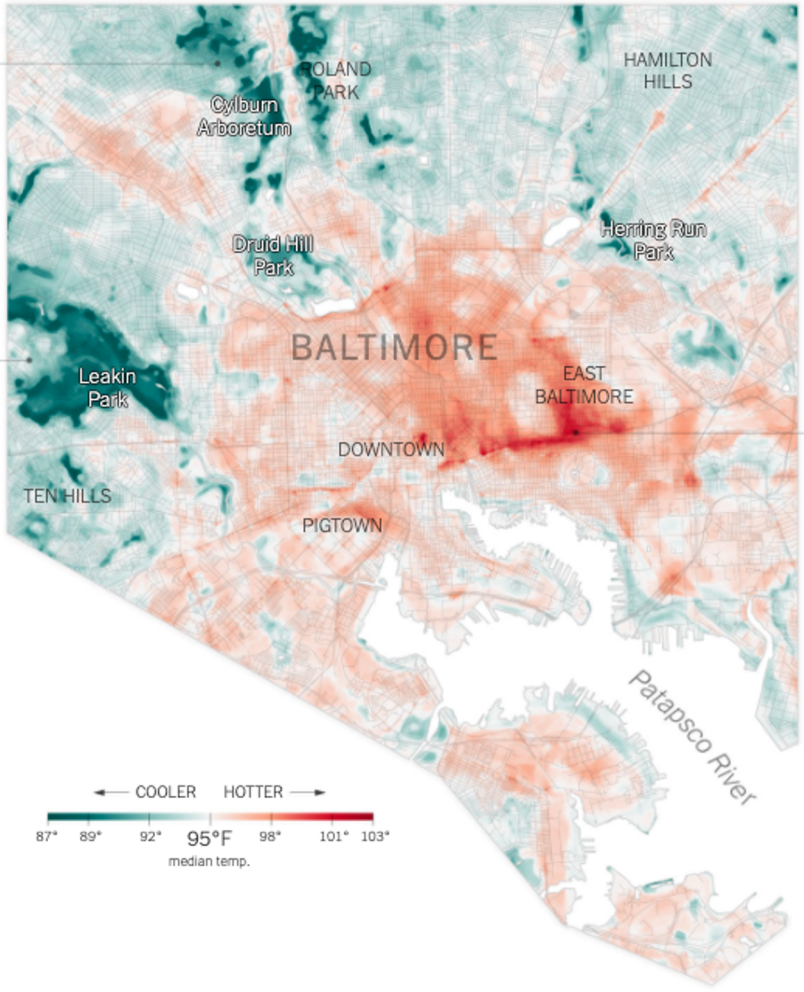
Extreme Heat Events

Cooler: Neighborhoods next to parks and those with plenty of tree cover saw significantly cooler temperatures on a hot summer afternoon: **as low as 87°F.**



Hotter: On the same day, residential neighborhoods east of downtown saw hotspots reach **over 101°F.**

BALTIMORE

AFTERNOON RANGE: 87°F TO 103°F

Warmer ← → **Cooler**

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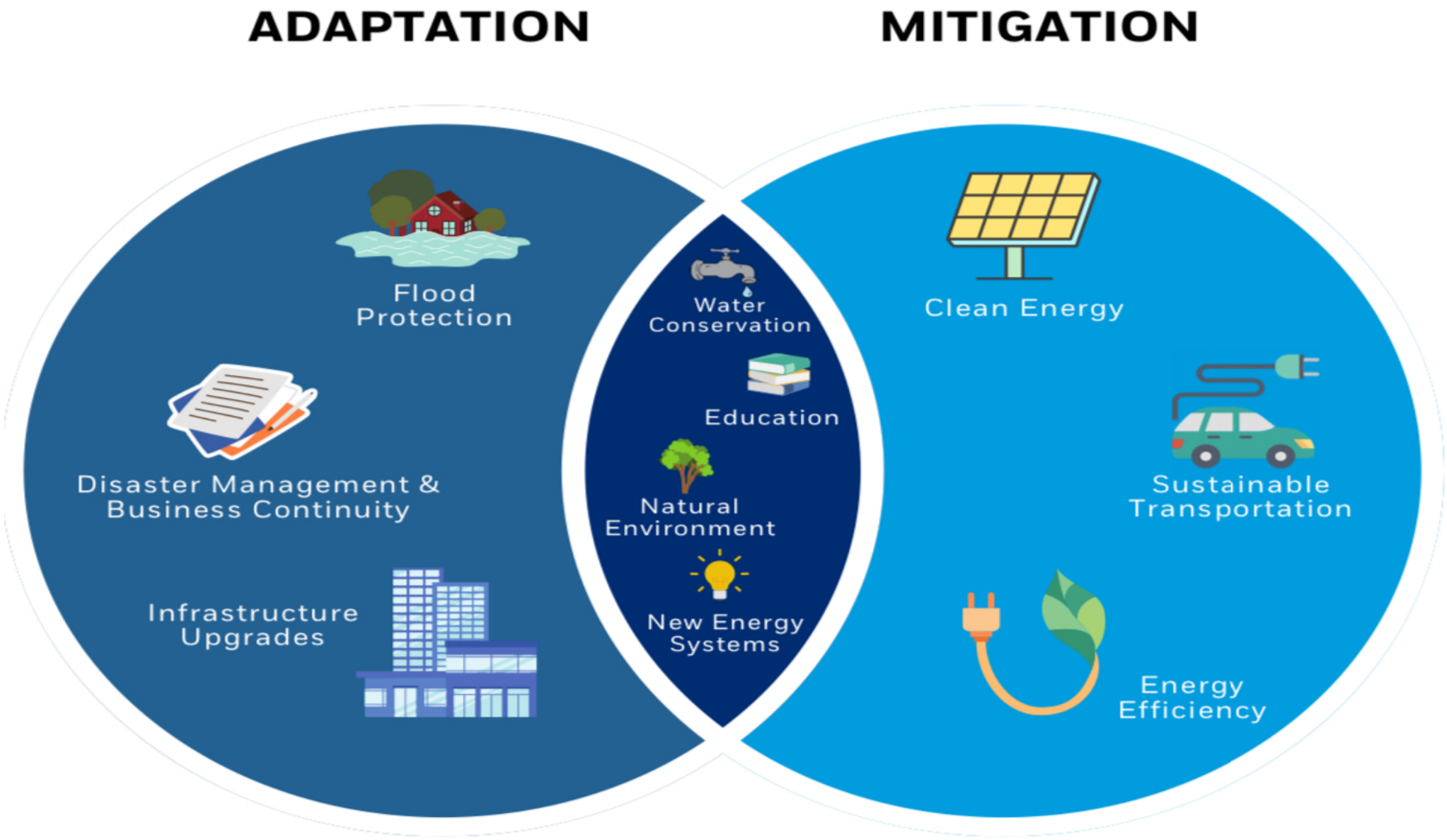
Solutions



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Mitigation - Climate Solutions Now Act (2022) - MD

- Reduce Greenhouse Gas Emissions by 60% by 2031 and Net Zero by 2045 (or 2035) (most ambitious goal in the states)
- New Building Codes focused on electrification and accounting for existing buildings
- Schools - net zero (including busses)
- Environmental Justice
- Chesapeake Conservation Corps - Mitigate CC and assist underserved communities
- Nuclear and Biofuels
- Funding

NCBO Work:

- Environmental Literacy - Informed decisions, systems thinking, solutions in schools, support for a workforce that will implement solutions

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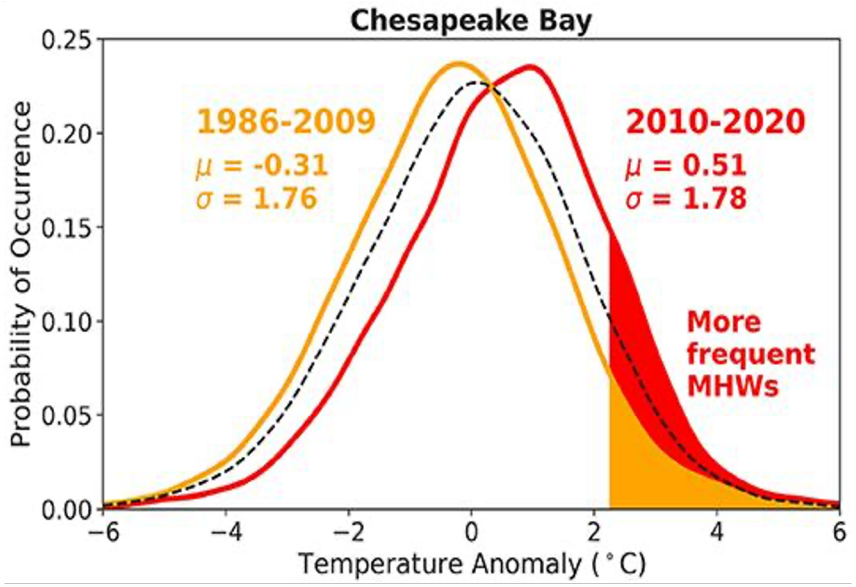
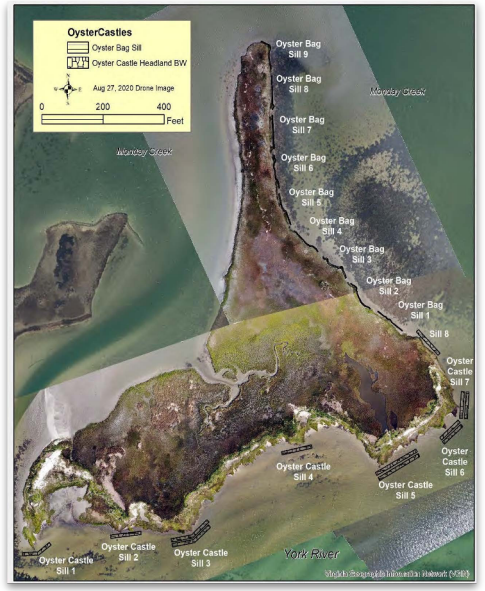
Resilience

NCBO Work:

- Creating a publicly available marine heatwave alert system to inform fishing behavior and management during extreme conditions–minimize stress to vulnerable species.
- Implementing shoreline protection strategies with nature-based solutions to minimize wave energy and expand lifespan of habitats under changing climate conditions.
- Environmental Literacy Programming - Resilience Hubs, climate and resilience workshops





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Food for Thought:

- How can we design our work to allow for success under future climate projections?
- Can we operate/design/fund to net zero or even net negative (or as close to this as possible)?

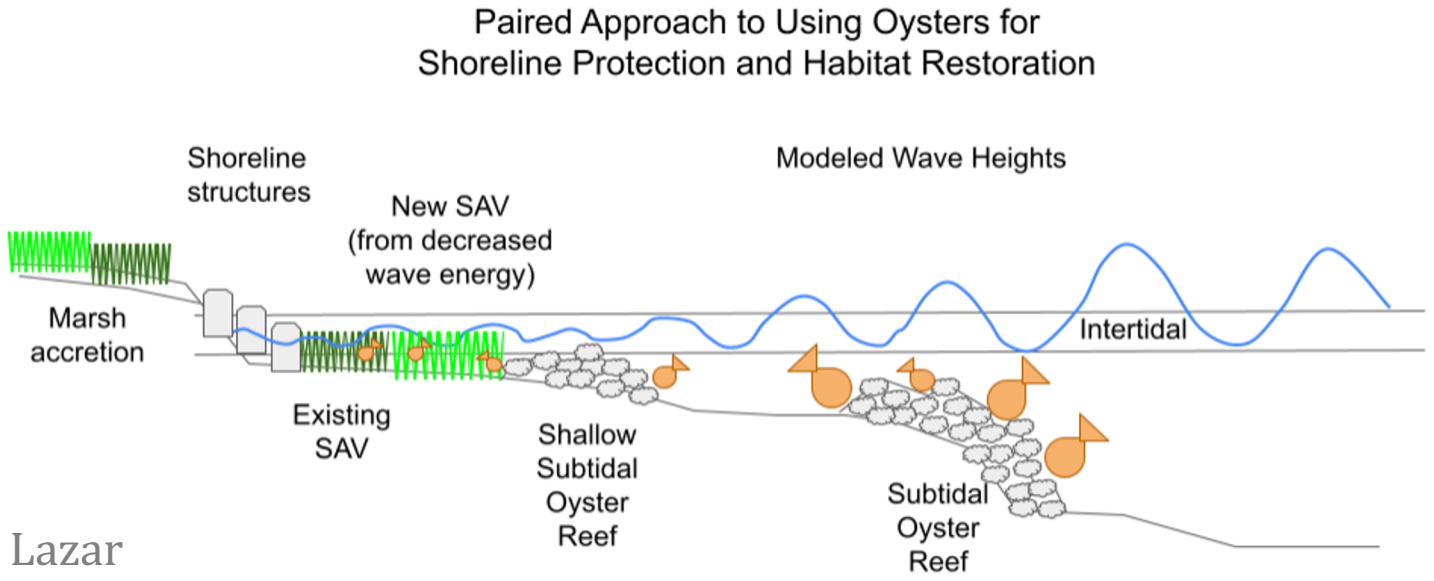

Image courtesy of Jay Lazar

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