

Climate Change and Resident Chesapeake Bay Striped Bass Habitat



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Changing Summer Distribution of Striped Bass

Since about 2005-2010, Maryland's summer-time striped bass fishery has become more concentrated in the northern end of its Chesapeake Bay summer range.

Information Sources:



- **Maryland DNR weekly fishing reports**
- **Fishtalk article** *"In the past decade or so, striped bass have more or less disappeared from much of the southern Chesapeake during the summer months. They've even become sparse in many parts of the middle Bay in recent years, ...[and] concentrated [in] schools north of the Chesapeake Bay Bridge."*
- **Maryland Bay fishing guides**

Striped Bass are a Valuable Resource

Striped Bass are an economic engine to Maryland and the east coast from North Carolina to Maine

Maryland

- State fish since 1965
- Maryland's recreational and commercial fishery worth \$802M (*American Sportfishing Association, 2016*) and provides over 10,000 jobs



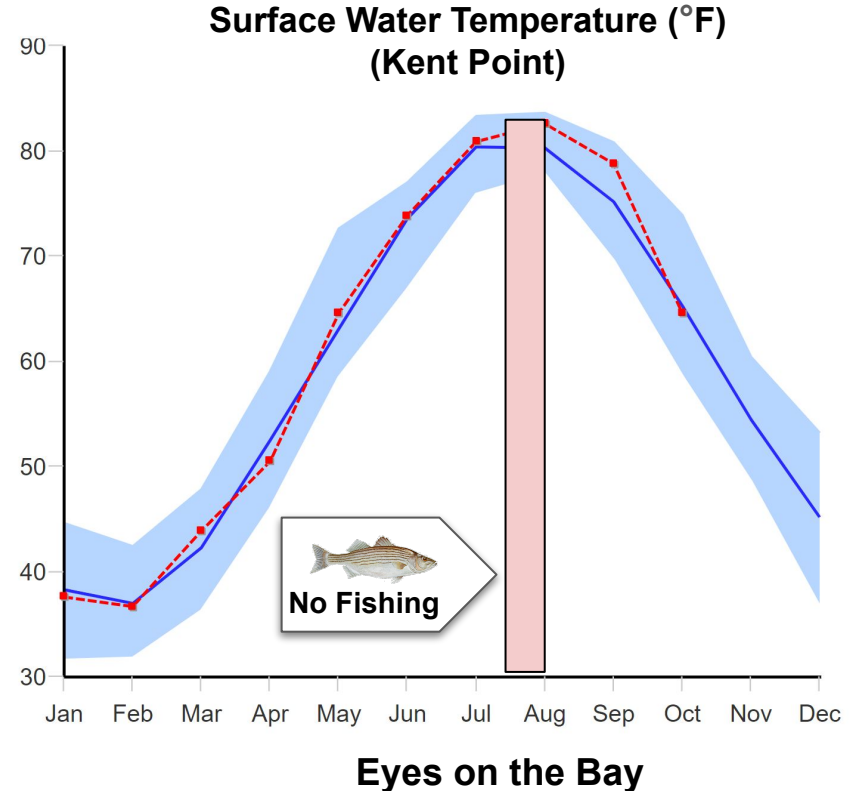
East Coast

- Chesapeake Bay provides up to 90% of coastal stock (*Richards & Rago, 1999*)
- East coast striped bass fishery is worth \$7.8B and supports over 100,000 jobs (*Southwick Associates, 2019*)



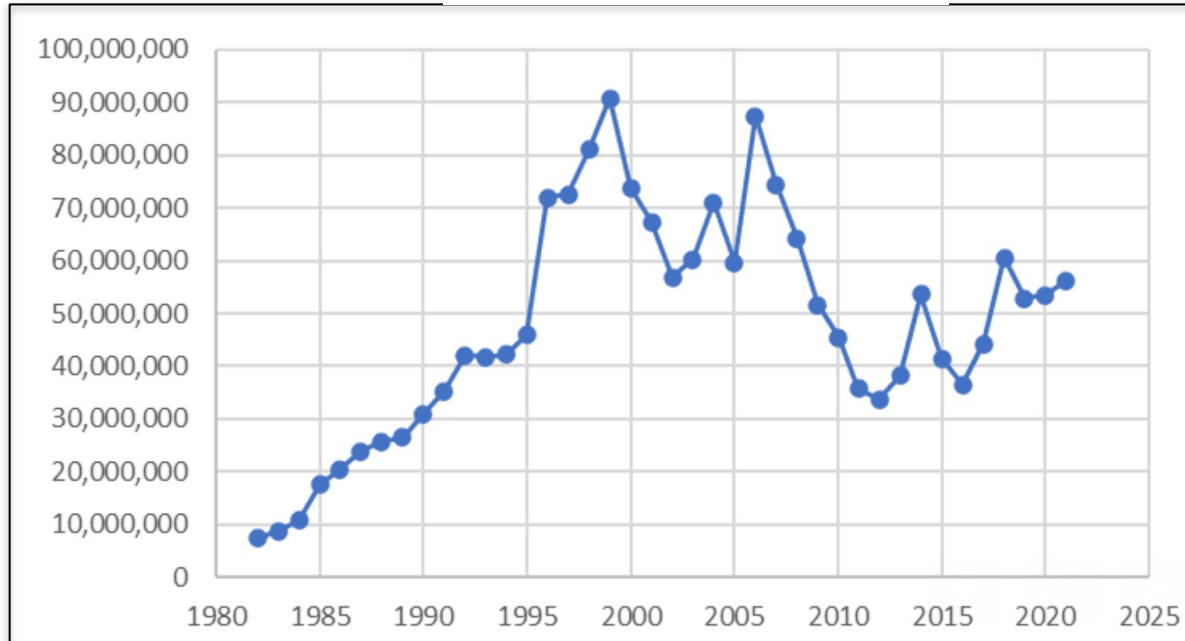
Current Status of Striped Bass Fishery

- **Striped Bass currently considered overfished** but no longer actively experiencing overfishing by Atlantic States Marine Fisheries Commission (ASMFC).
- **Changing harvest allocations for Maryland aren't expected.**
- **Habitat Issues Recognized** - Maryland prohibited fishing for Striped bass during the last two weeks of July to reduce stress on the bay population during the period when hypoxia and water temperatures are at their worst.



Declining Resident Striped Bass Abundance

Striped Bass Abundance
(Ages 3 to 6 year old)



- In the past 15 years, abundance of 3 to 6 year old striped bass (MD Sea Grant, 2009) has declined about 30% (ASMFC striped bass assessment 2020 update)

Changing Chesapeake Bay

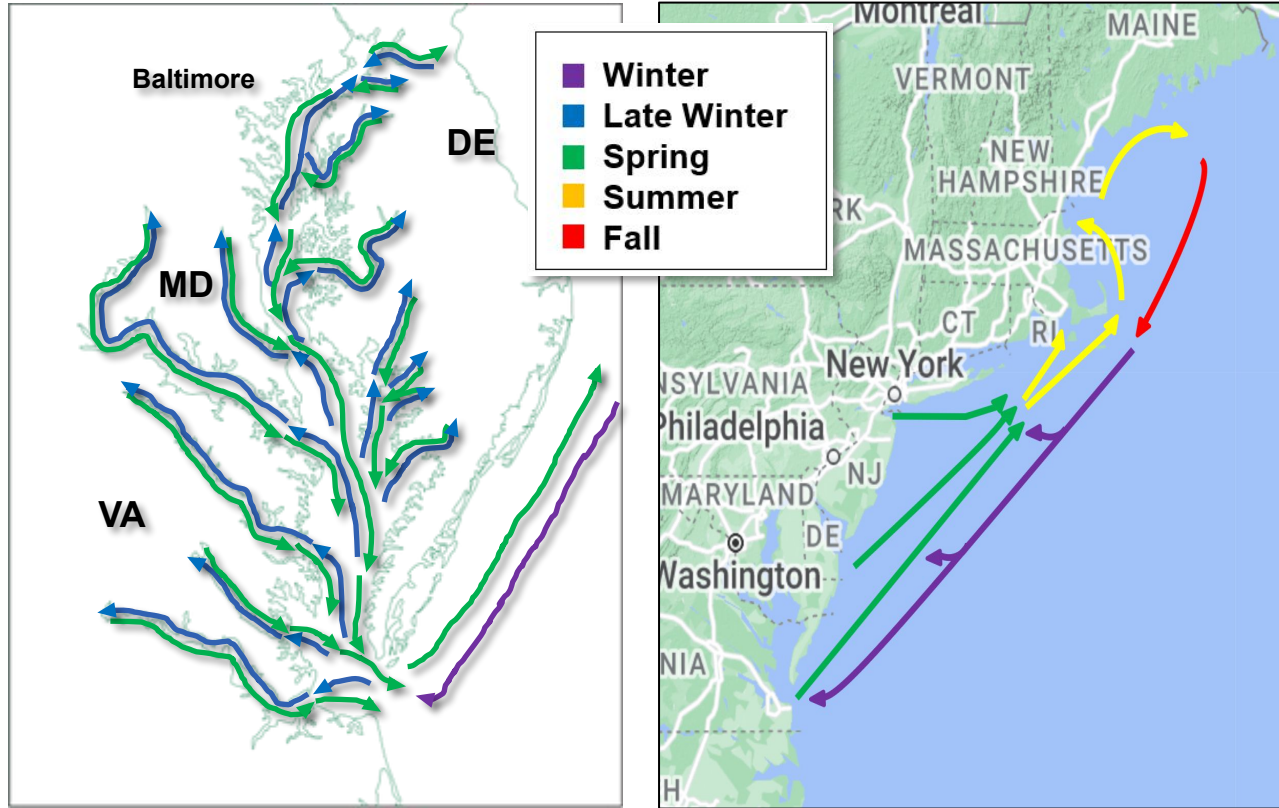
Nutrient and Sediment Reduction

- Since the 1980's and more aggressive recently, Bay States have been working to reduce excess nutrients and sediment to increase available oxygen for Bay organisms and clearer water for SAV.

Climate Change Impacts

- Bay water temperature increasing over last three decades - Most Bay stations showing between 1° to 2°F increase since 1999. Increases are not consistent throughout water column.
- Marine heat waves becoming more frequent in Bay waters (*Mazzini and Pianca, 2021*)

Seasonal Movement of Migratory Striped Bass



Migratory Striped Bass



- Mostly females at least 4-8 years old (~23" to 30" and larger to ~50") join the coastal migratory stock
- Leave Bay by summer and don't return until mid-winter/early spring
- Larger than resident fish

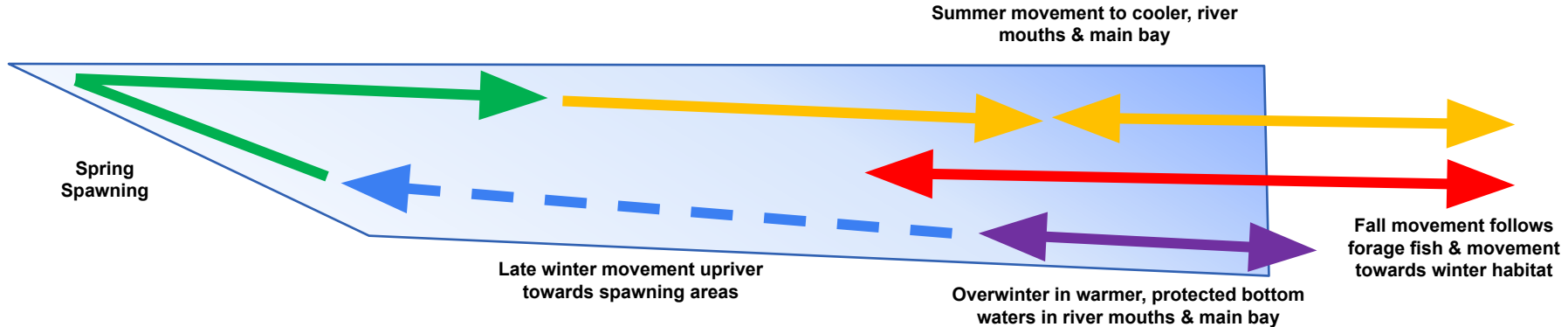
Seasonal Movement of Resident Striped Bass

Resident Striped Bass



- After spawning, most males, some immature females, and a few mature females stay in Maryland waters.
- Most fish are < 6 years old and < 29" (4 - 5.5 lbs)
- Year-round population providing Maryland's major recreational and commercial fishery.
- Commercial and recreational minimum size is 18" and 19" respectively.

- Winter
- Late Winter
- Spring
- Summer
- Fall



Changing Summer Location of Resident Striped Bass

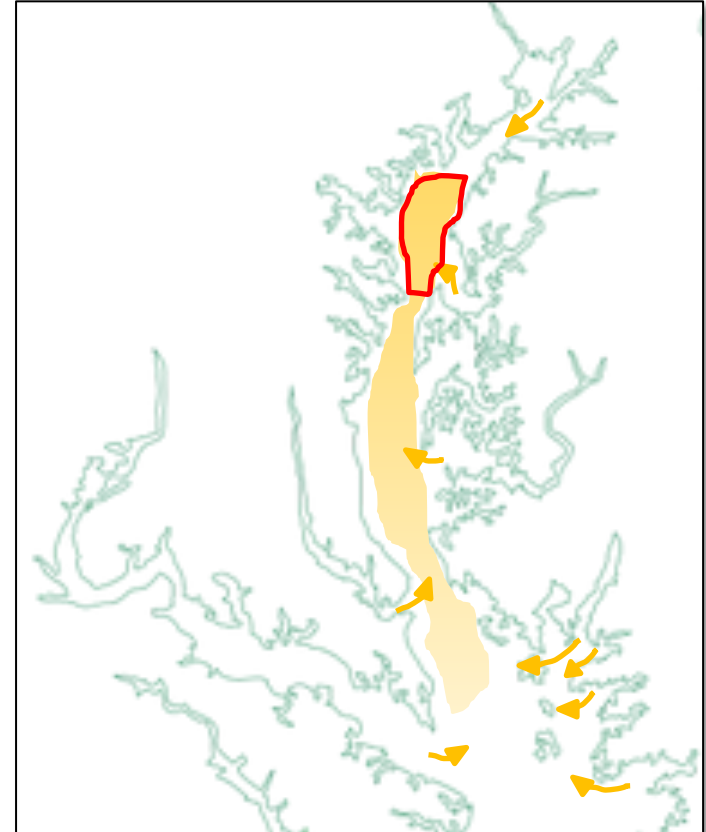
Concentration of Summer Resident Striped Bass

Prior to 2005-2010

- Typically located in major river mouths
- Primarily main Bay from about mouth of Potomac River north to Gunpowder River, Tangier Sound

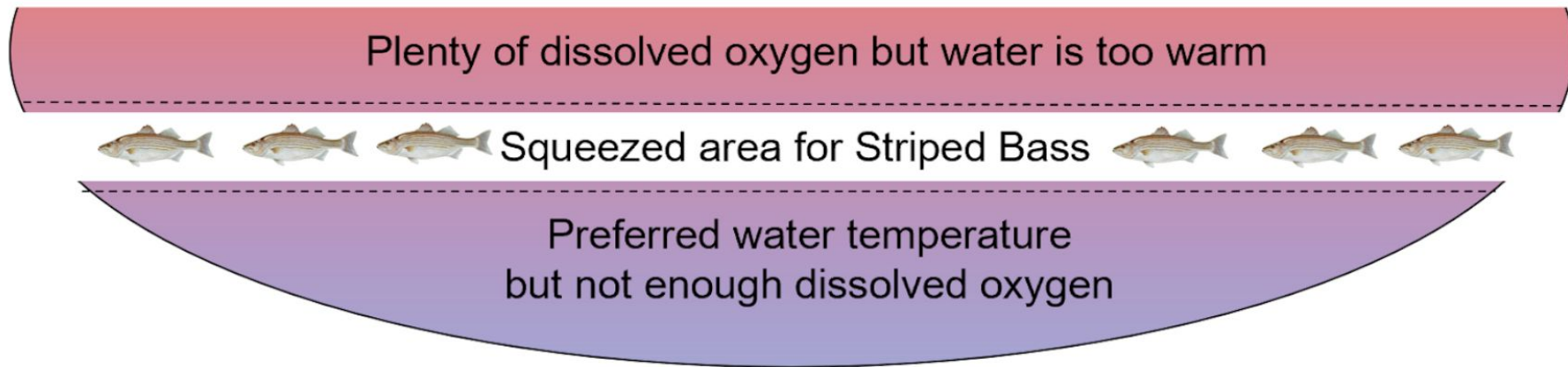
Transition period of 2010 to 2020

- Moved out of river mouths to the main bay
- Current summer concentration in main bay from near Bay Bridge north to Gunpowder River



Striped Bass Squeeze





In warmer summer months, elevated surface water temperatures and increasing amounts of oxygen poor bottom waters force striped bass into a very narrow band of cooler water with adequate oxygen.



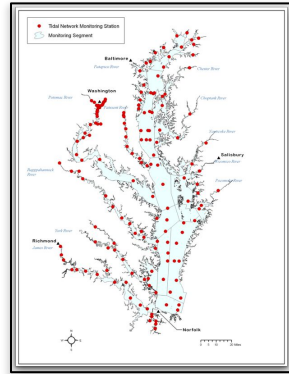
Determining Summer Habitat Thresholds for Resident Striped Bass

- Needed dissolved oxygen (DO) and water temperature requirements for “typical” resident fish during worst habitat conditions (June - August)
 - Smaller fish are more tolerant of poor water quality and larger fish less tolerant
- Developed requirements using results from scientific literature: Bioenergetics models, direct observation, tagging, telemetry, and literature reviews.
 - Mostly Bay specific with some reservoir studies
- Four habitat categories: Suitable, Tolerable, Marginal, and Unsuitable

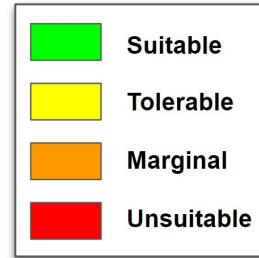
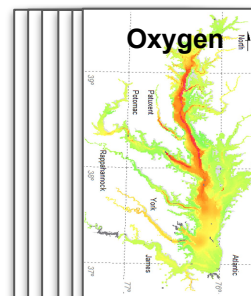
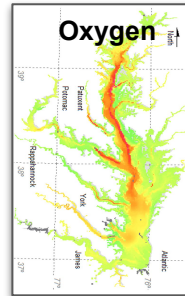
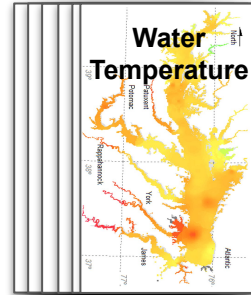
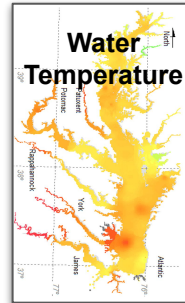
Revised Striped Bass Categories and Thresholds for Dissolved Oxygen (DO) & Water Temperature (WT)

-  **Suitable** - Supports "normal" occupancy and growth potential
DO ≥ 4 mg/l, WT $\leq 82.4^{\circ}\text{F}$ (28°C)
-  **Tolerable** - Supports occupancy for a modest period of time with limited growth potential (~1 month)
DO < 4 mg/l & ≥ 3 mg/l, WT $> 82.4^{\circ}\text{F}$ (28°C) & $\leq 84.2^{\circ}\text{F}$ (29°C)
-  **Marginal** - Supports occupancy for a short period with little or no growth potential (Just passing through)
DO < 3 mg/l & ≥ 2 mg/l, WT $> 84.2^{\circ}\text{F}$ (29°C) & $\leq 86^{\circ}\text{F}$ (30°C)
-  **Unsuitable** - Not suitable conditions experiencing either hypoxia or excess water temperature
DO < 2 mg/l, WT $> 86^{\circ}\text{F}$ (30°C)

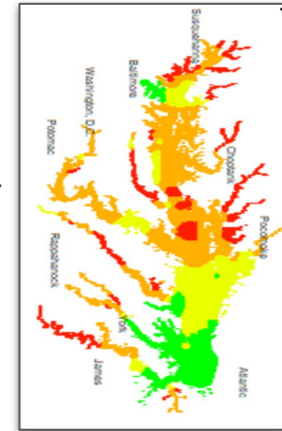
Assessing Baywide Striped Bass Habitat Conditions



Compile Bay data from each cruise at 165 stations from 1986 to 2020



Apply Striped Bass Habitat Thresholds



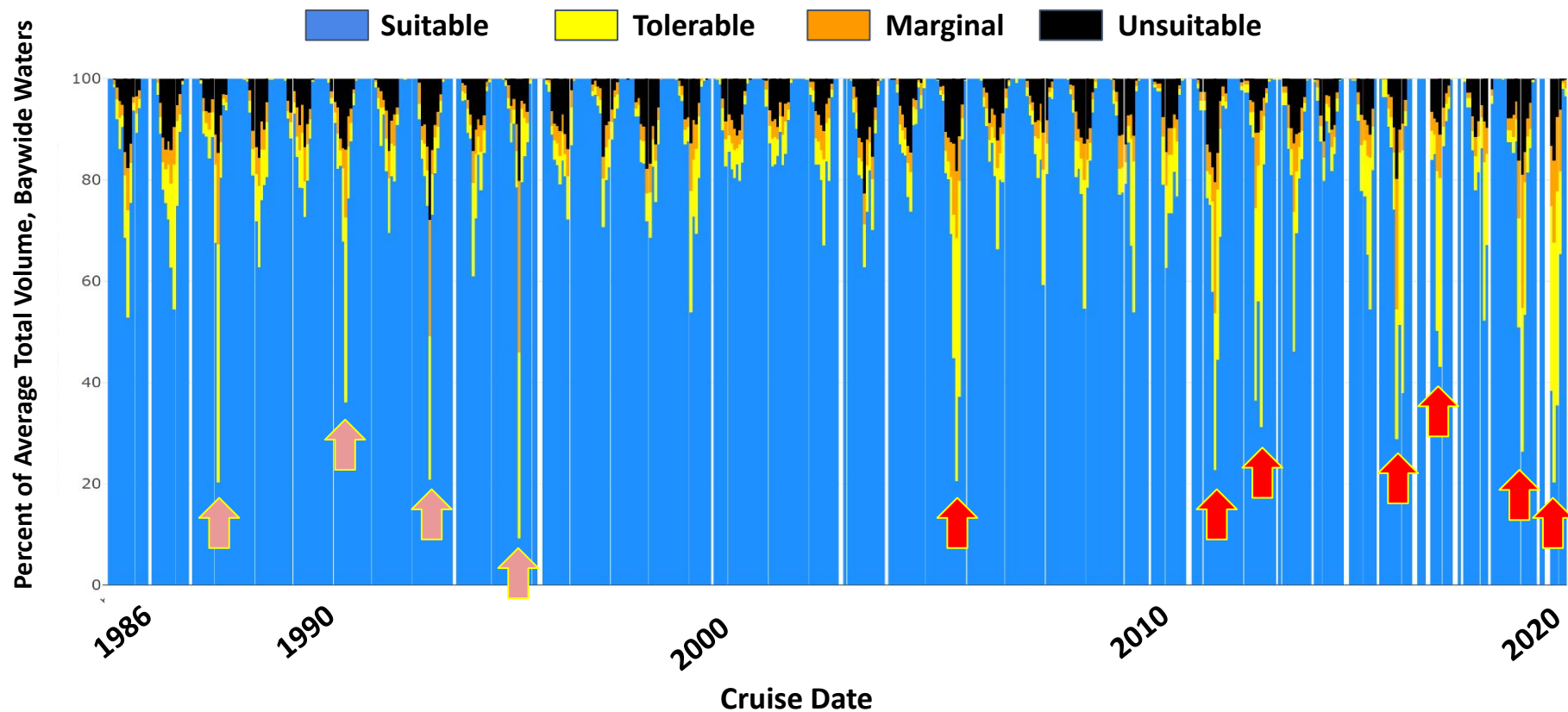
Assess Striped Bass Habitat

By cruise, interpolate data to create 3D Bay for Oxygen & Water Temperature

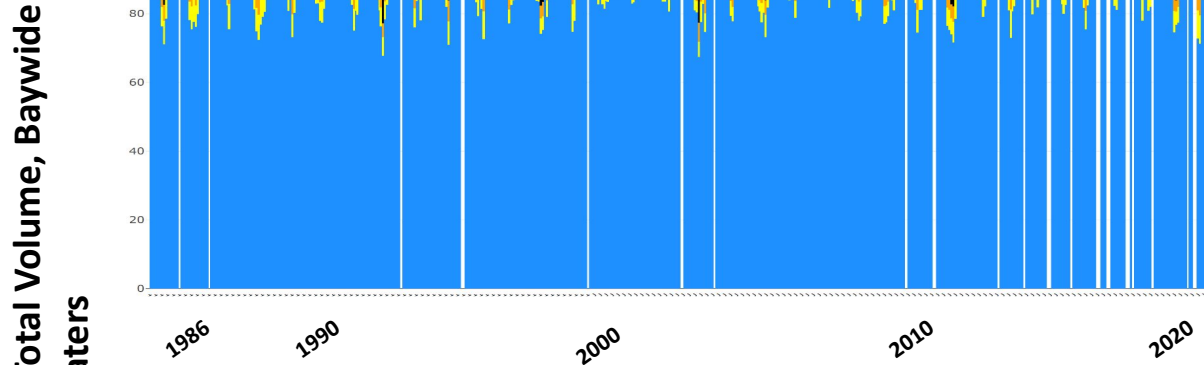
Repeat for each of the 509 cruises

**How have Baywide Striped Bass habitat
conditions changed since 1986?**

Baywide Striped Bass Habitat Conditions



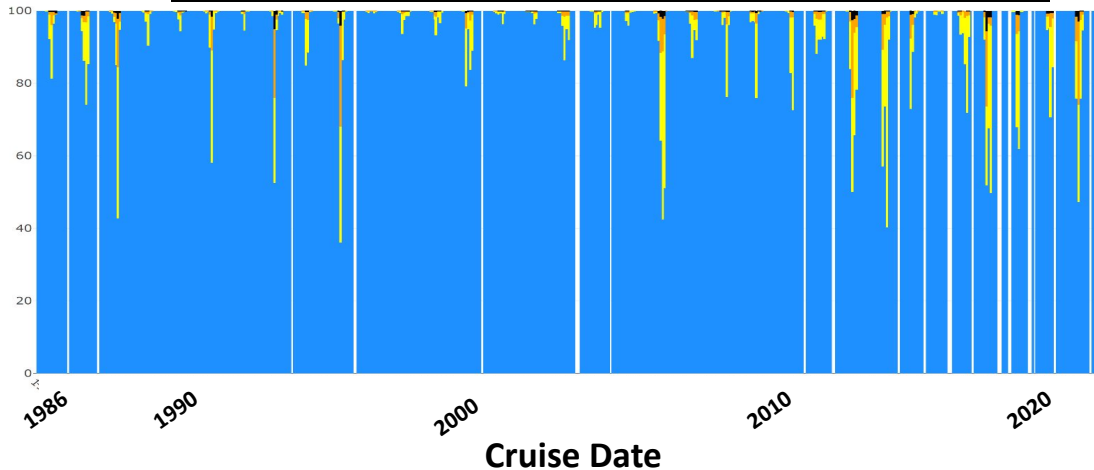
Striped Bass Dissolved Oxygen Conditions



Oxygen Summary

- Despite nutrient & sediment reductions, conditions relatively stable over time
- No trends over any time period

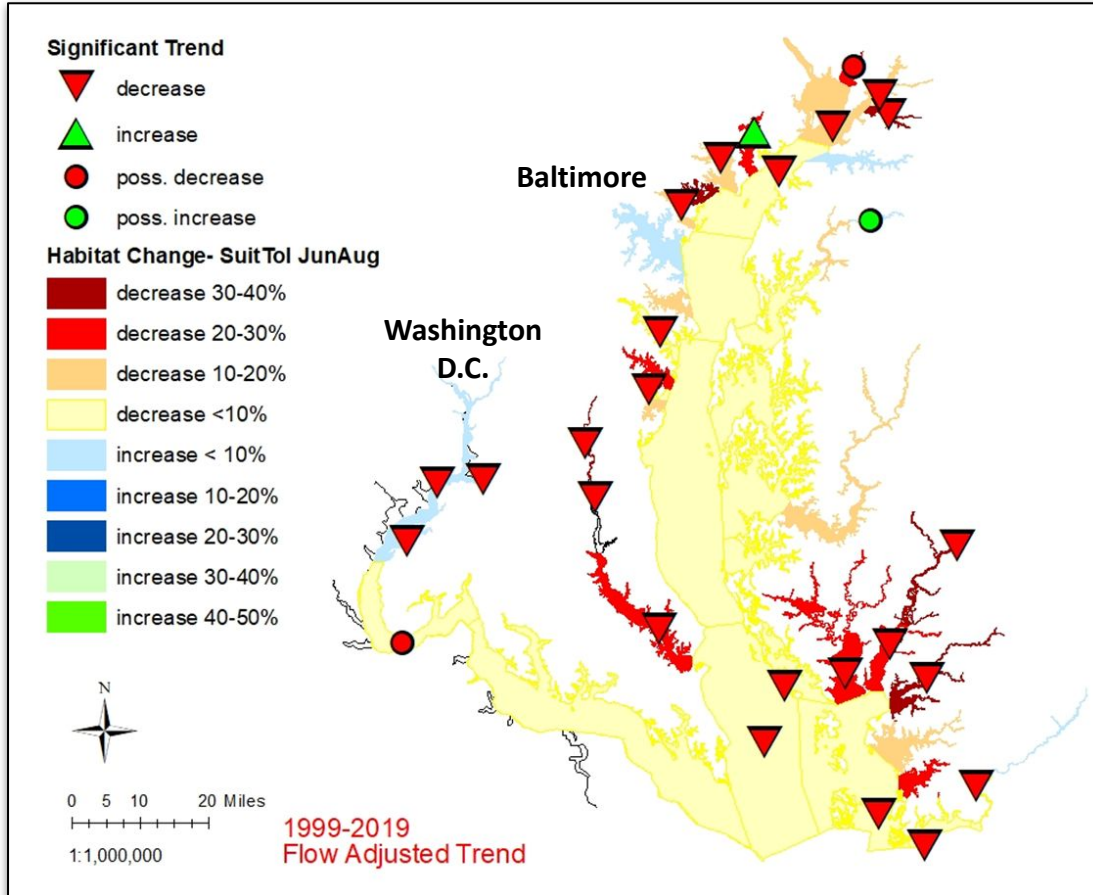
Striped Bass Water Temperature Conditions



Water Temperature Summary

- Conditions degrading in frequency and duration since about 2010

Striped Bass Habitat Change & Trends



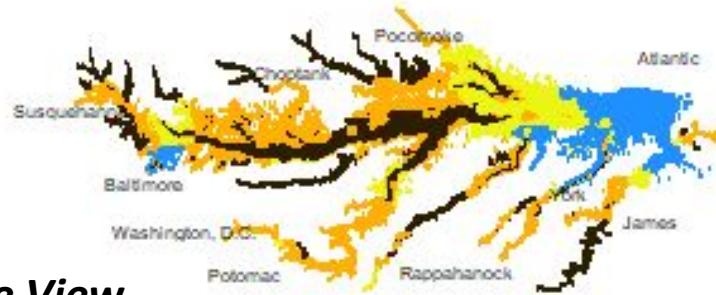
These habitat conditions have degraded over the last 20 years

While primarily due to increasing water temperatures, there is evidence of degrading dissolved oxygen conditions 3m-8m in CB3MH, CB4M & EASMH

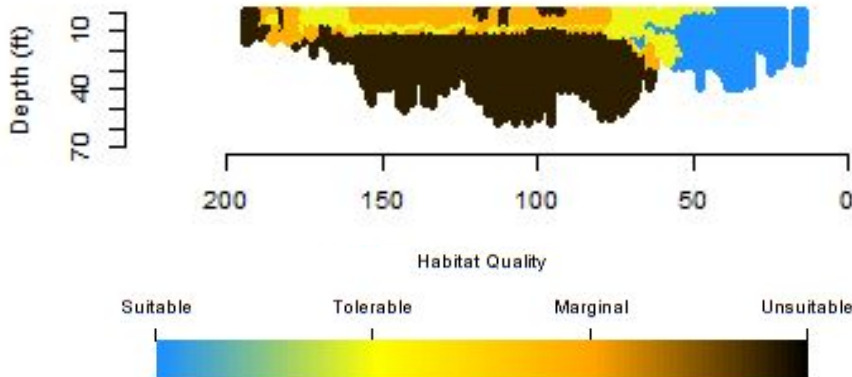
Episodic Chesapeake Bay Striped Bass Habitat Conditions

Example – July 15-31, 2019

Top View



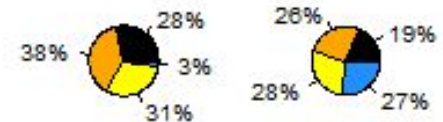
Side View



Not only have habitat conditions degraded, these conditions are becoming more frequent, longer lasting and severe

- Suitable** - Supports "normal" long-term occupancy with growth potential
- Tolerable** - Supports occupancy for a modest period of time, ~ 1 month, with limited or negative growth potential
- Marginal** - Supports very brief occupancy with little impact on growth potential
- Unsuitable** - Does not support occupancy

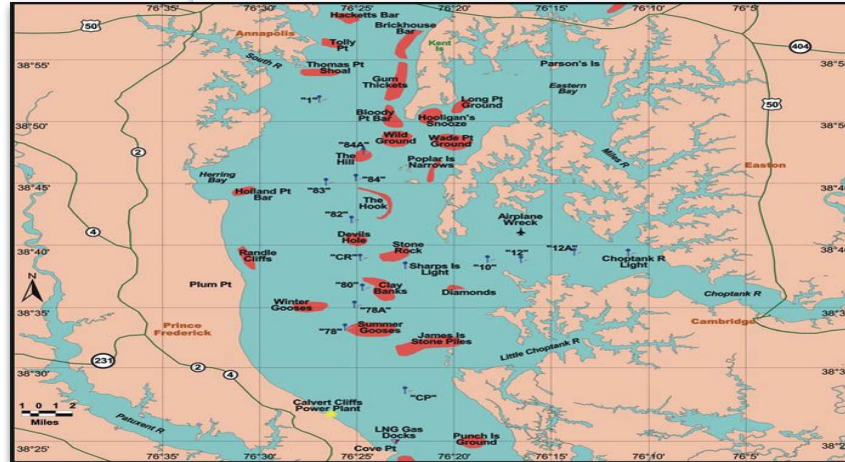
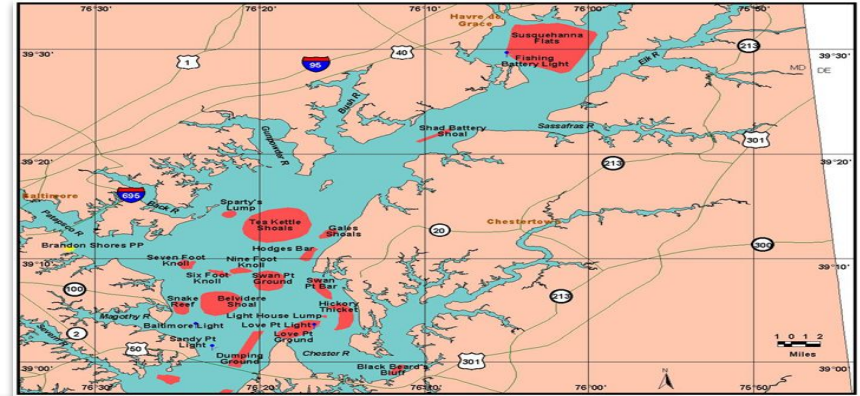
Habitat Quality (%)



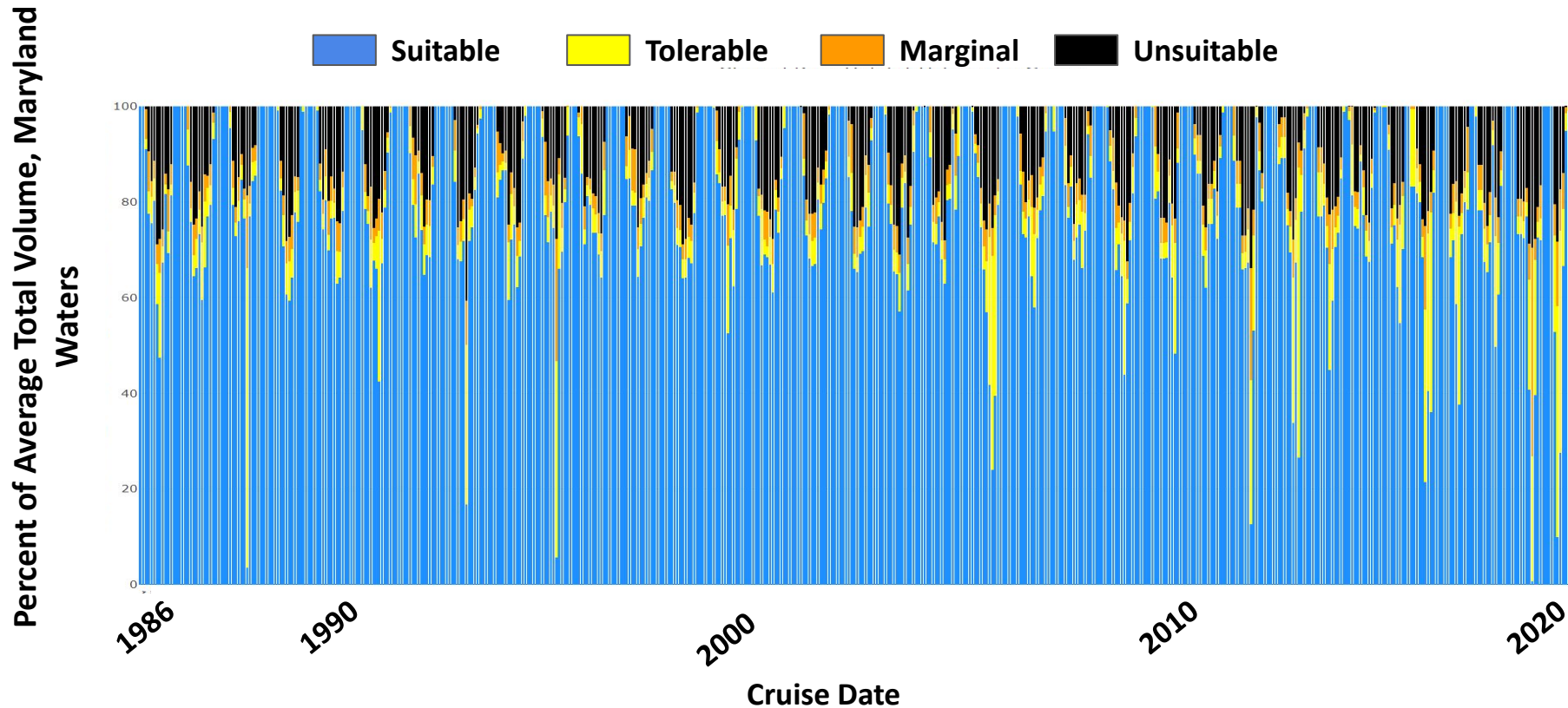
Maryland

Baywide

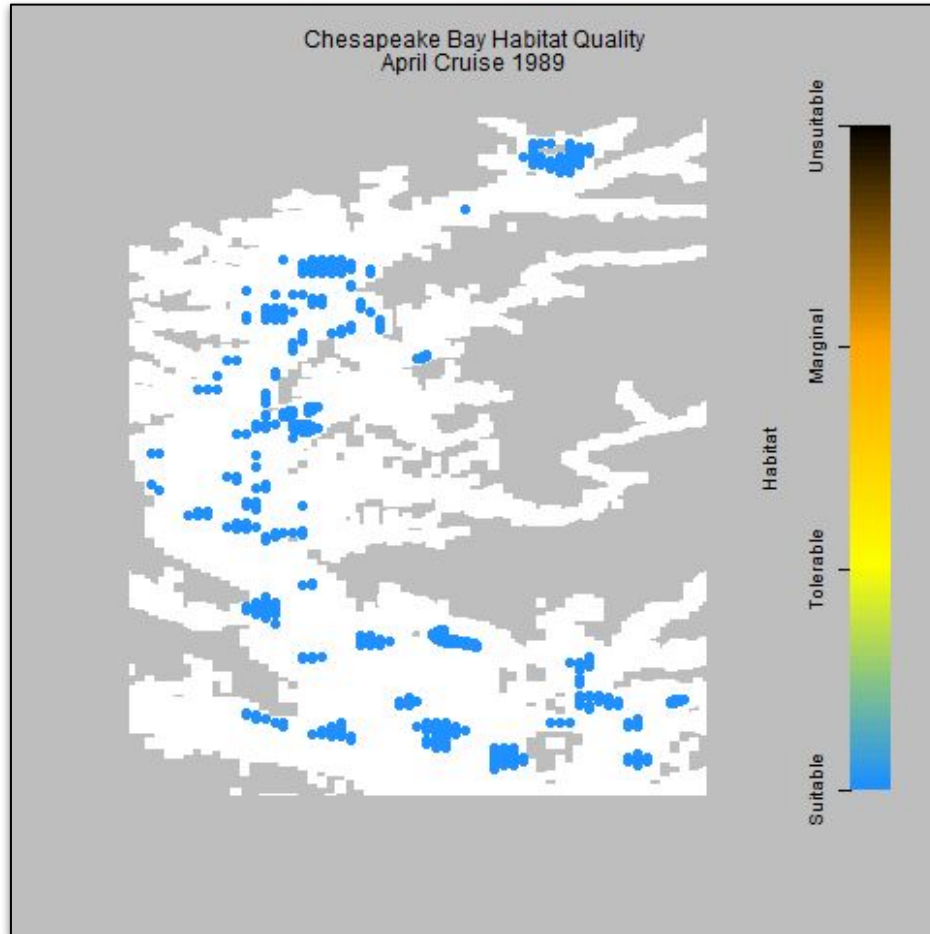
How have Baywide Striped Bass habitat conditions in prime fishing areas changed since 1986?

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Habitat Conditions at Prime Maryland Fishing Areas



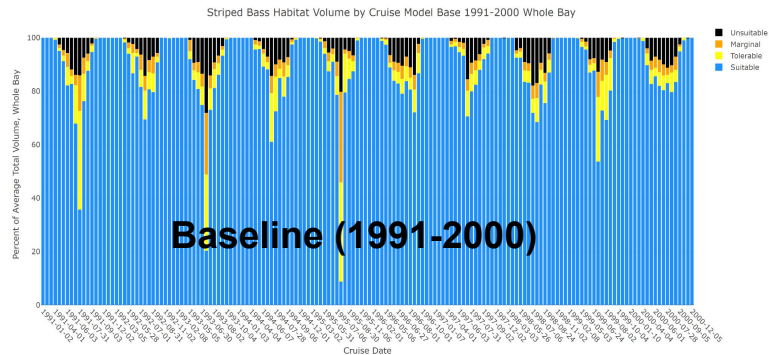
Typical Monthly Striped Bass Habitat Conditions at Prime Fishing Areas



Summary

- Prime Maryland fishing areas are important habitat areas where fish congregate
- Habitat conditions at prime fishing areas mirror baywide patterns
- Habitat conditions at prime Maryland fishing areas are more degraded than baywide conditions

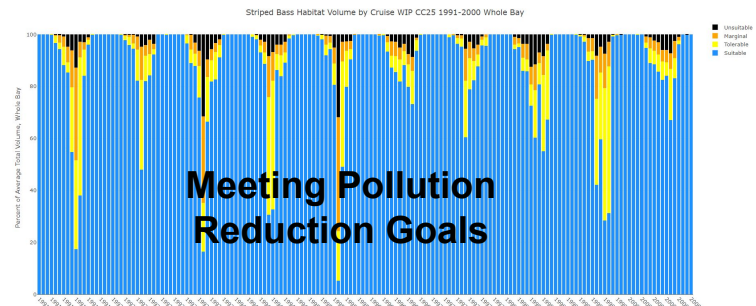
**What is impact to striped bass habitat
volume by meeting nutrient and
sediment reduction goals?**



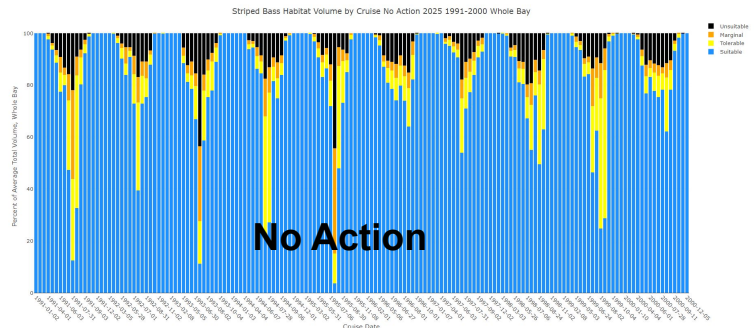
Habitat - Baywide



Where we were



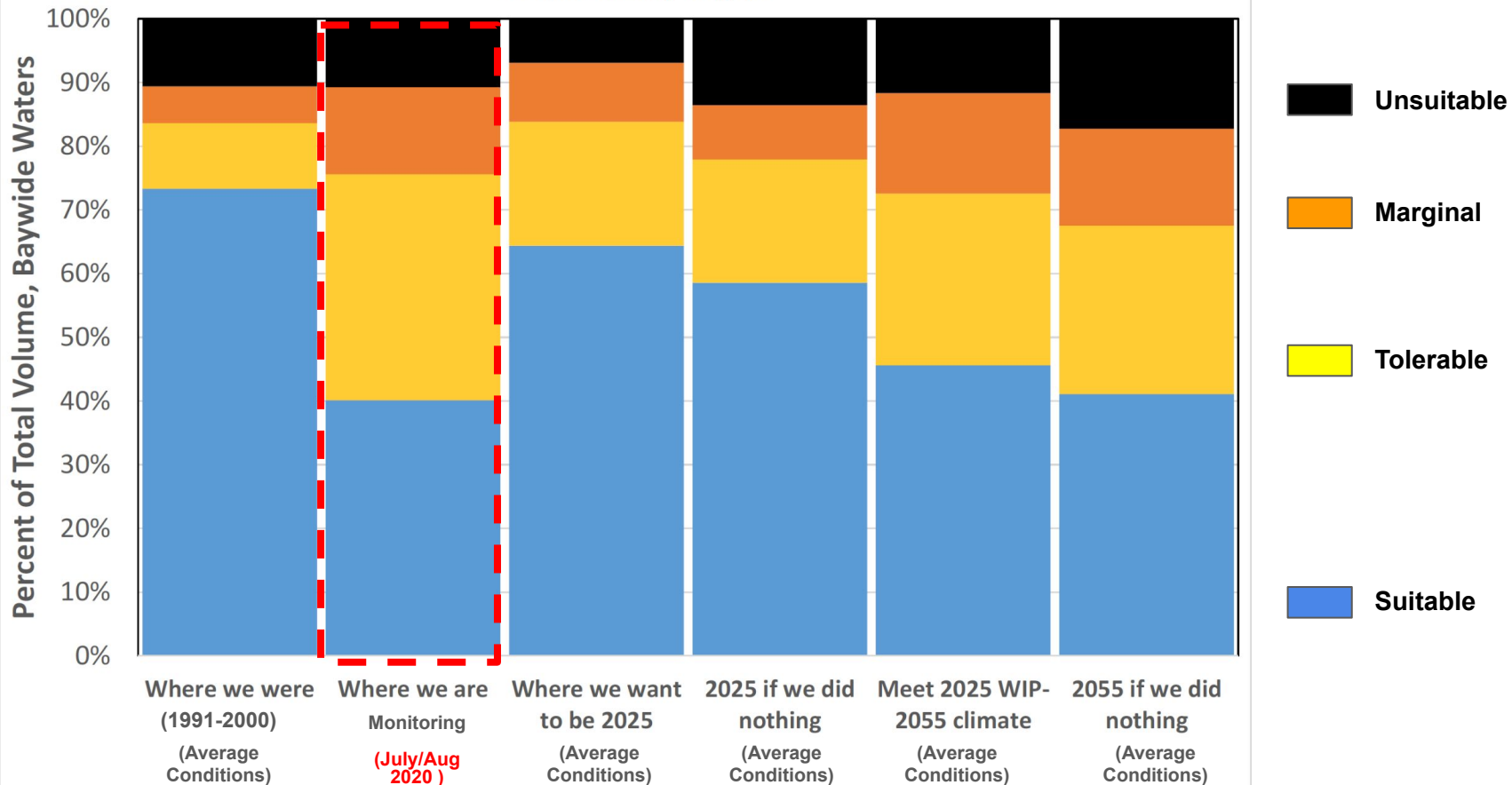
Where we want to be (2025)



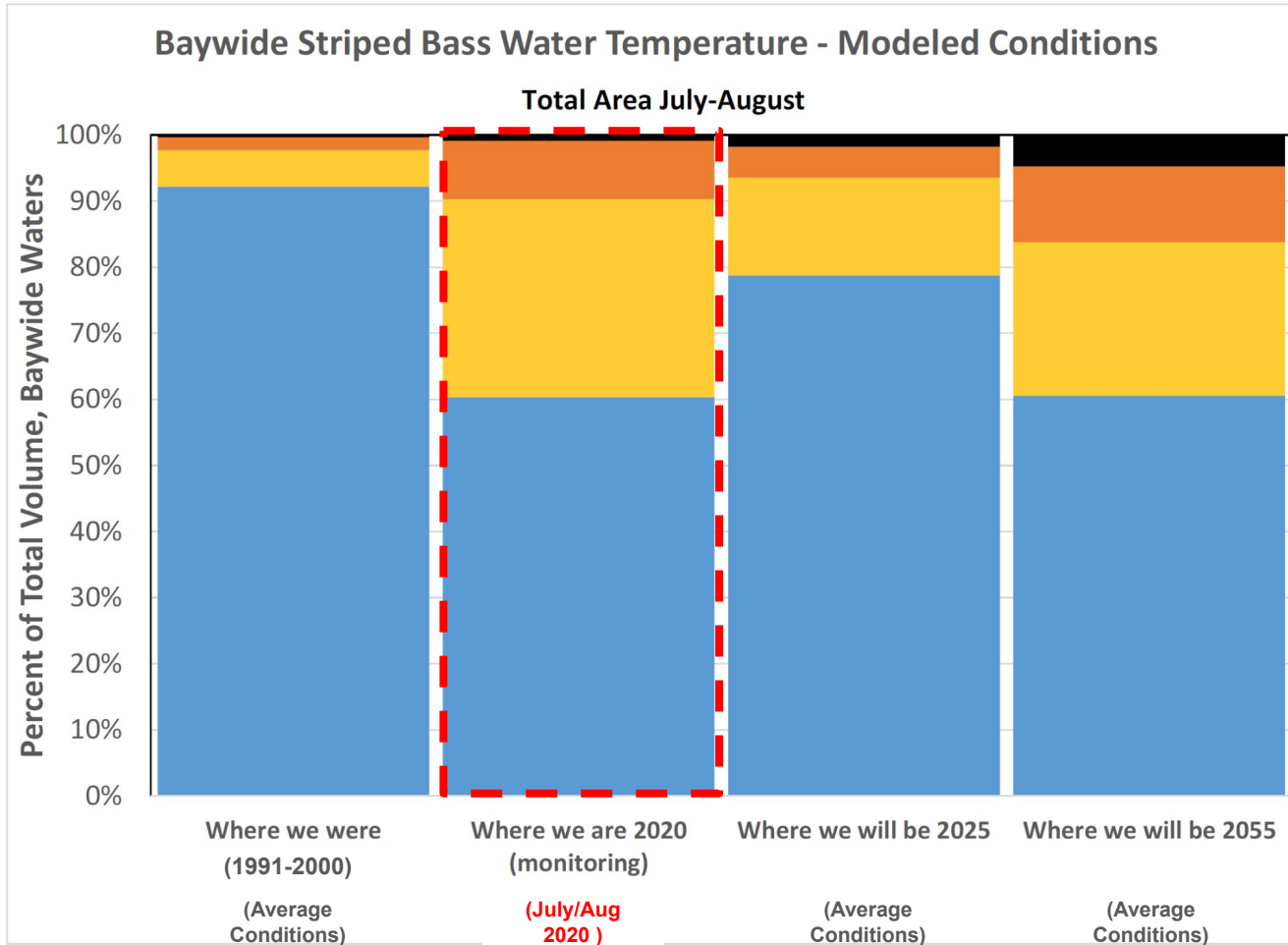
Where we would be in 2025 if we did nothing and there was no Bay Program partnership

Baywide Striped Bass Habitat - Modeled Conditions

Total Area July-August

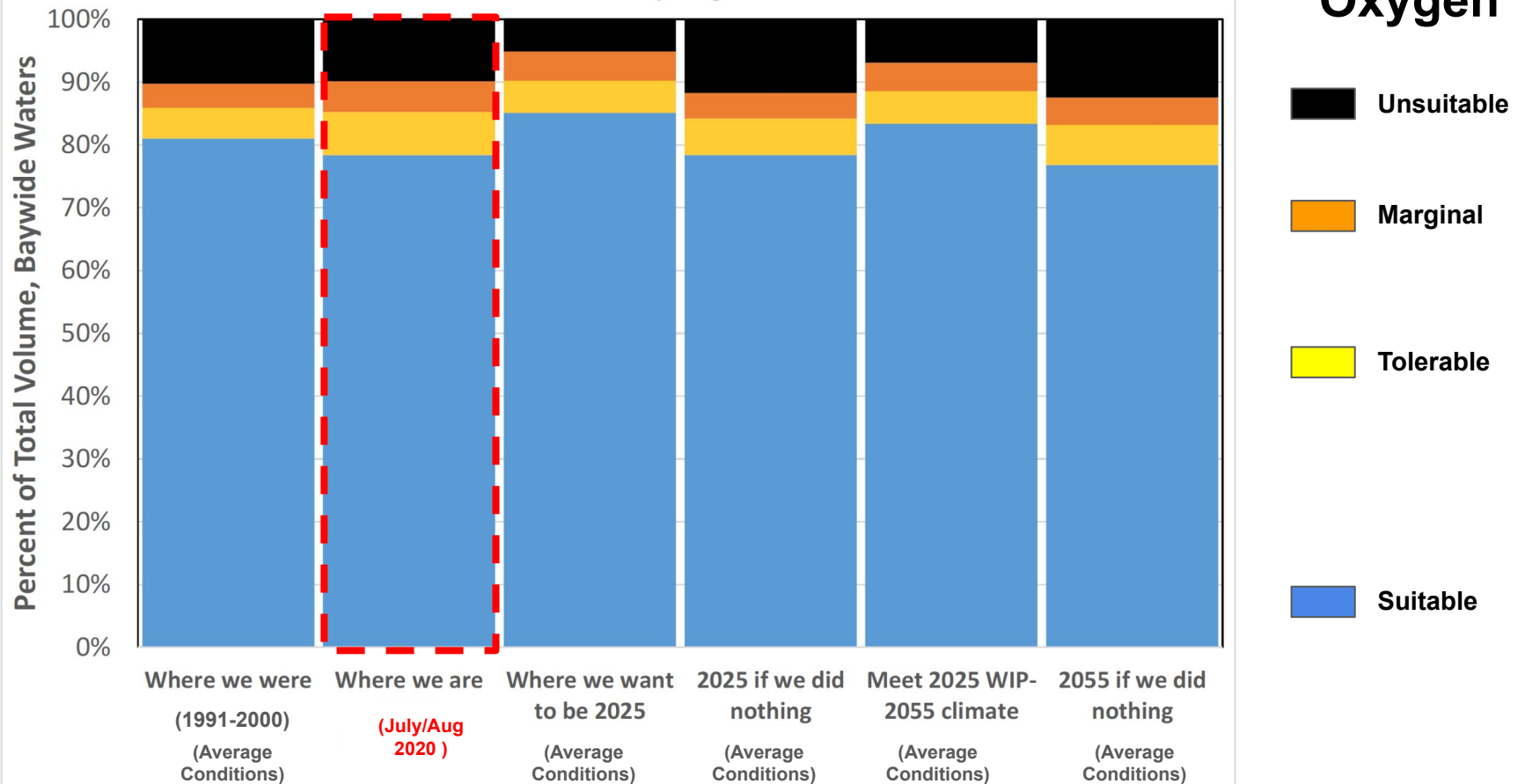


Water Temperature

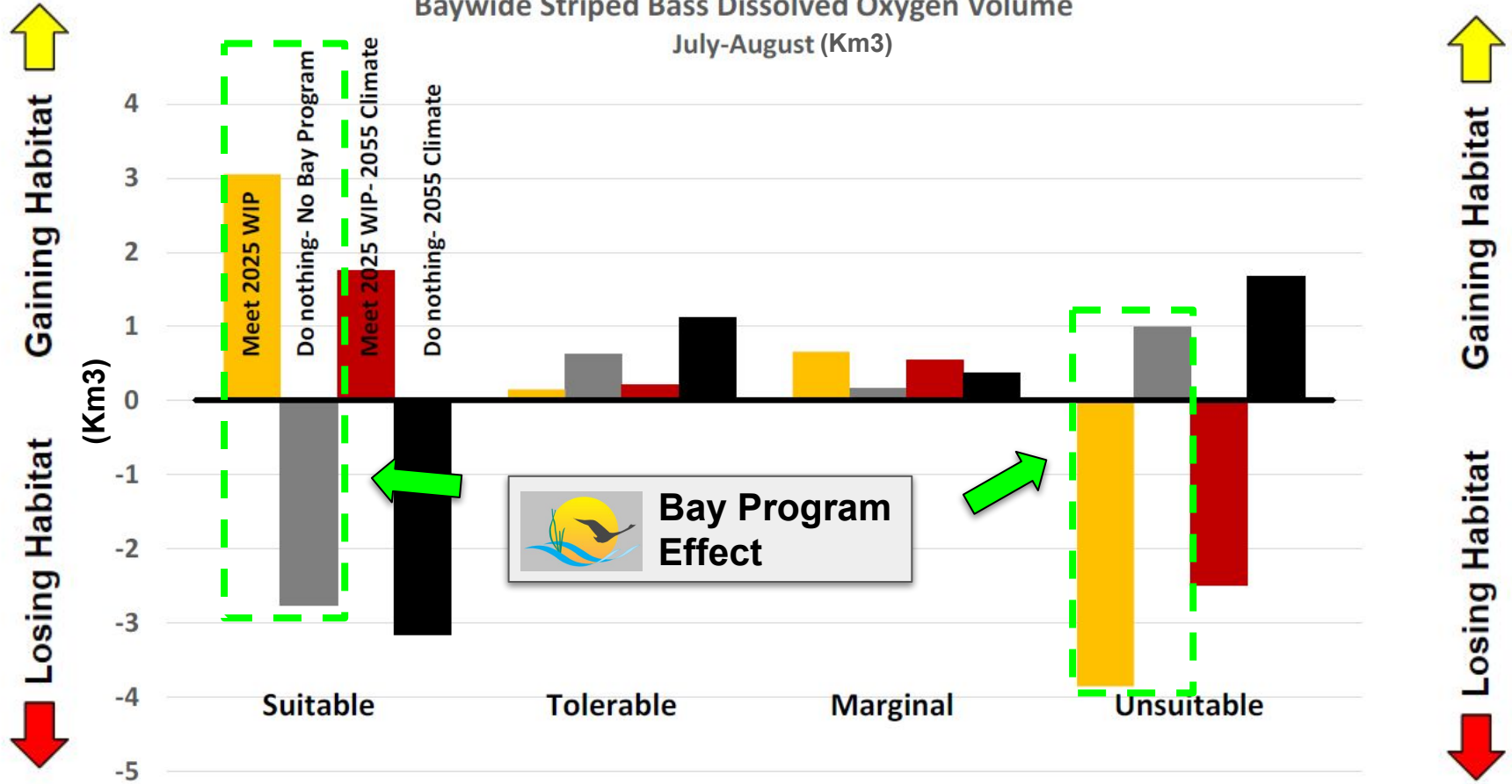


Baywide Striped Bass Dissolved Oxygen- Modeled Conditions

Total Area July-August



Pollution Reduction Scenarios
Baywide Striped Bass Dissolved Oxygen Volume
July-August (Km3)



Baywide Striped Bass Water Temperature Volume

July-August

(% Change)

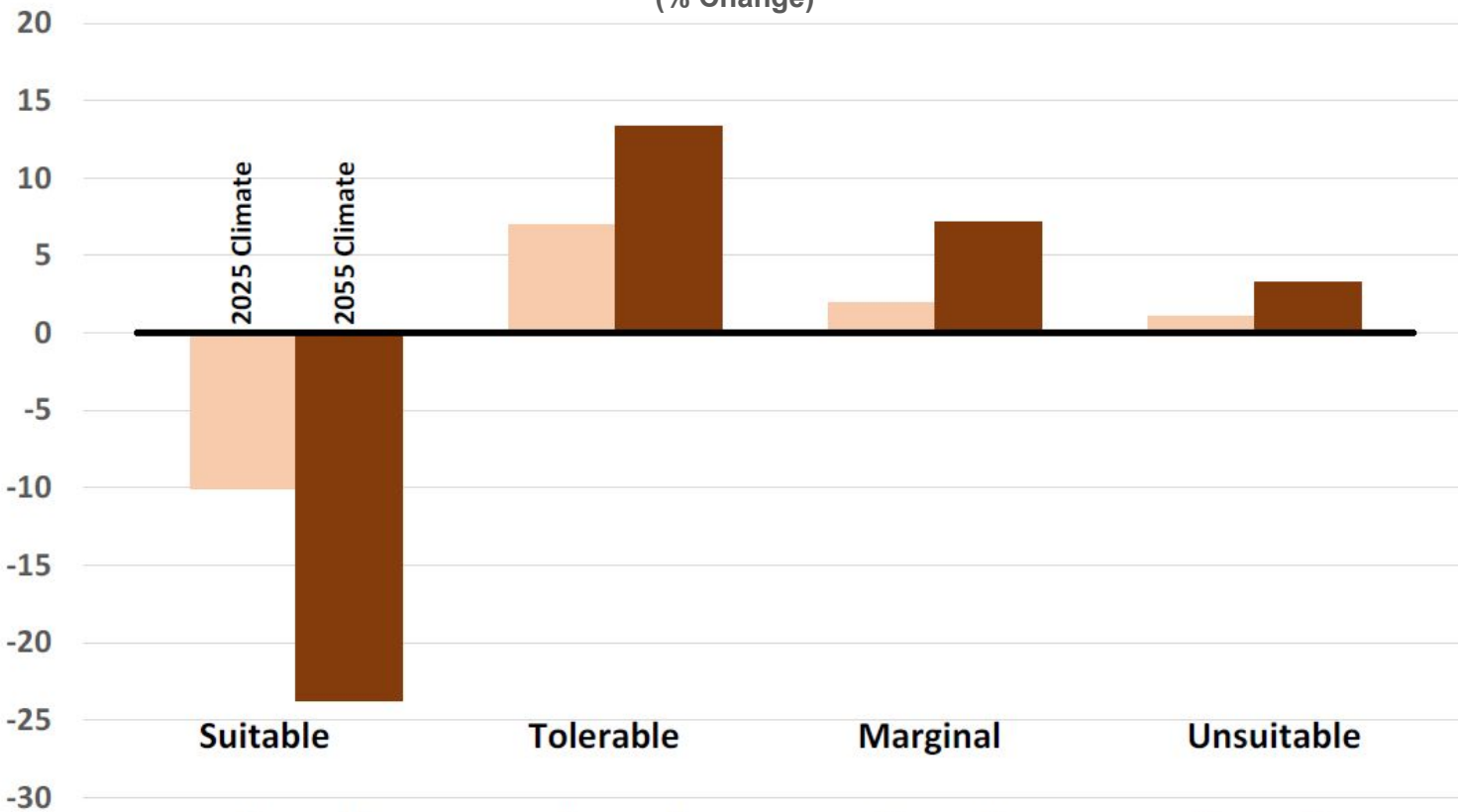
(% Change)

Gaining Habitat

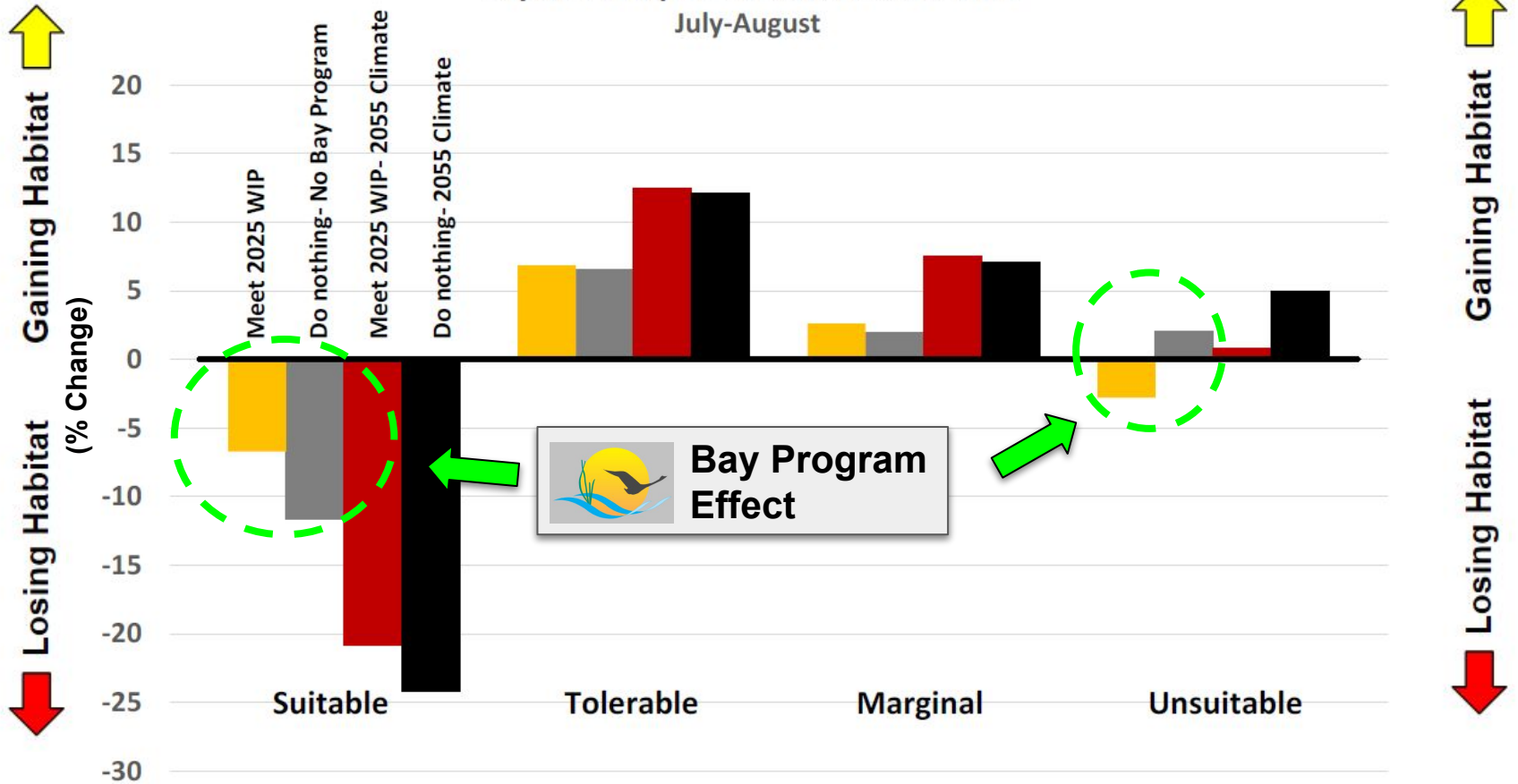
Losing Habitat

Gaining Habitat

Losing Habitat



Pollution Reduction Scenarios
Baywide Striped Bass Habitat Volume
July-August



What is the Baywide impact to striped bass habitat (DO & Water Temperature) to meeting nutrient and sediment reduction goals?

Against the headwinds of climate change and warming Bay waters, we are still seeing some restoration progress

With the Chesapeake Bay Program partnership and if we meet our goals (WIP3) in 2025

- Will lose 8.2% (3.7 km³) suitable habitat volume; reduce unsuitable volume 52.8% (3km³)

Without the Bay Program partnership and we did nothing, in 2025

- Lose 17.1% (8.6 km³) suitable habitat volume; increase unsuitable volume 29.2% (1.9 km³).

How will climate change impact future Baywide striped bass habitat?

If we meet our 2025 goals, but experience 2055 climate conditions

- Losing 27.3% (14.1 km³) suitable volume, lose 19% (0.3 km³) unsuitable volume. Habitat quality shifts to more tolerable, and marginal volume.

If we did nothing and there was no Bay Program partnership, in 2055

- Losing 33% (or 17.7 km³) suitable volume; gain 55% (4 km³) unsuitable volume. Habitat quality degrades and shifts to tolerable, marginal, and unsuitable volume.

Note: These are averaged conditions. Episodes of degraded conditions may become more frequent, longer and possibly more stressful/lethal than current episodes.

Summary of Past & Present Conditions (1986-2020)

- Compressed Bay spatial distribution of striped bass may reflect habitat and/or smaller population contracting to its core range
- Striped bass habitat has degraded since 1986, mostly in the last 10-20 years. In Maryland, Suitable & Tolerable habitat has decreased ~10%
- In prime habitat (fishing) areas, conditions follow similar pattern of increasing frequency, intensity and duration but a higher % of habitat is degraded
- Increasing water temperature is the major driver, however, degrading oxygen conditions are also occurring mid-water in some segments

Summary of Future Conditions (2025-2055)

- The Chesapeake Bay fishery will likely experience more frequent, longer lasting and more degraded habitat conditions.
- In 2055, increasing water temperatures, will decrease suitable volume 31% (with nutrient reduction); tolerable, marginal and unsuitable areas will increase.
- **CBP Effect** - In 2025, if nutrient and sediment restoration goals are met, the Bay will only be losing 8% of suitable volume. This will shift unsuitable volume into marginal or tolerable habitat.
- Despite increasing water temperature being the primary driver to impacting striped bass habitat, it is still extremely important to continue nutrient and sediment reduction actions.

Questions?



*Special thanks to **Maryland DNR (Resource Assessment Service)** Bay monitoring, data management, analysis and administrative folks and also **Maryland DNR Fisheries staff***