Climate Change and Resident Chesapeake Bay Striped Bass Habitat

Tom Parham, Jim Uphoff, Andrew Keppel, Renee Karrh

MARYLAND DEPARTMENT OF NATURAL RESOURCES

&

Chesapeake Bay Program Modeling Team

January 2023

Striped Bass are a Valuable Resource

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

Maryland

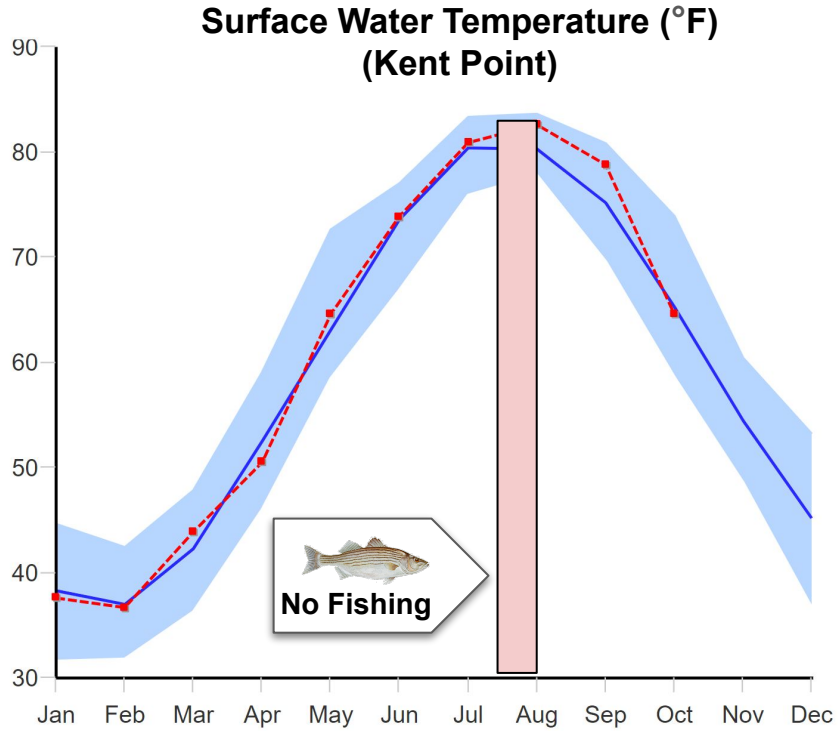
- State fish since 1965
- Maryland's recreational and commercial fishery worth $802M (*American Sportfishing Association, 2016)* and provides over 10,000 jobs

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.



Changing Chesapeake Bay

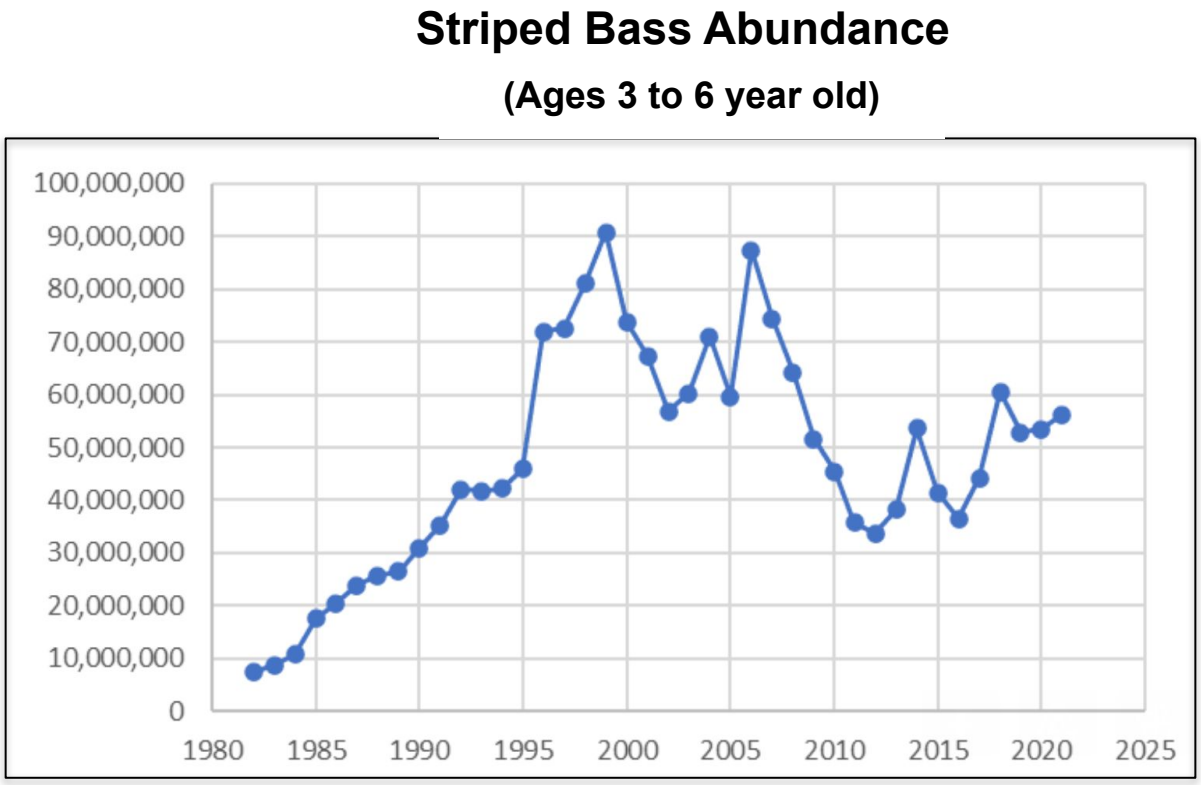
Nutrient and Sediment Reduction

- 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

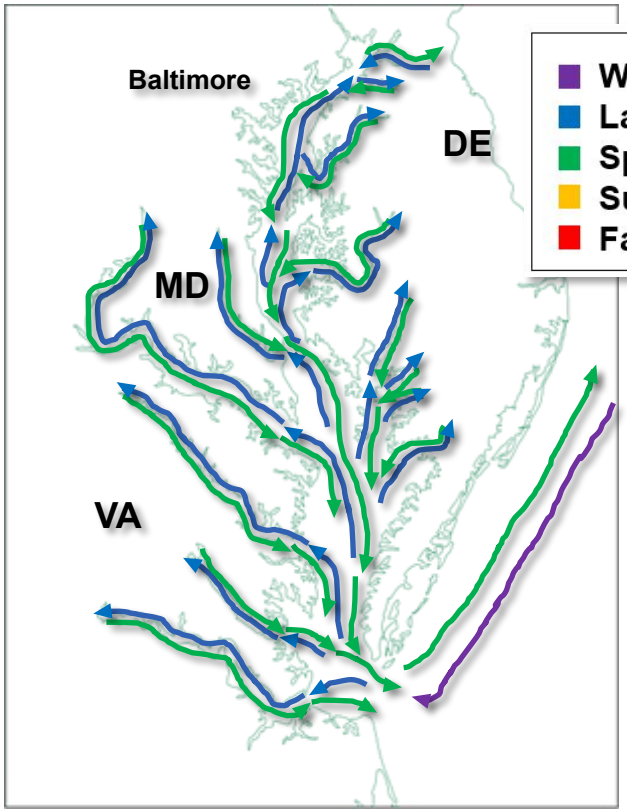
- Bay water temperature increasing over last three decades - Most Bay stations showing between 1° to 2°F increase since 1999. Increases are not consistent throughout water column.
- Marine heat waves becoming more frequent in Bay waters *(Mazzini and Pianca, 2021)*

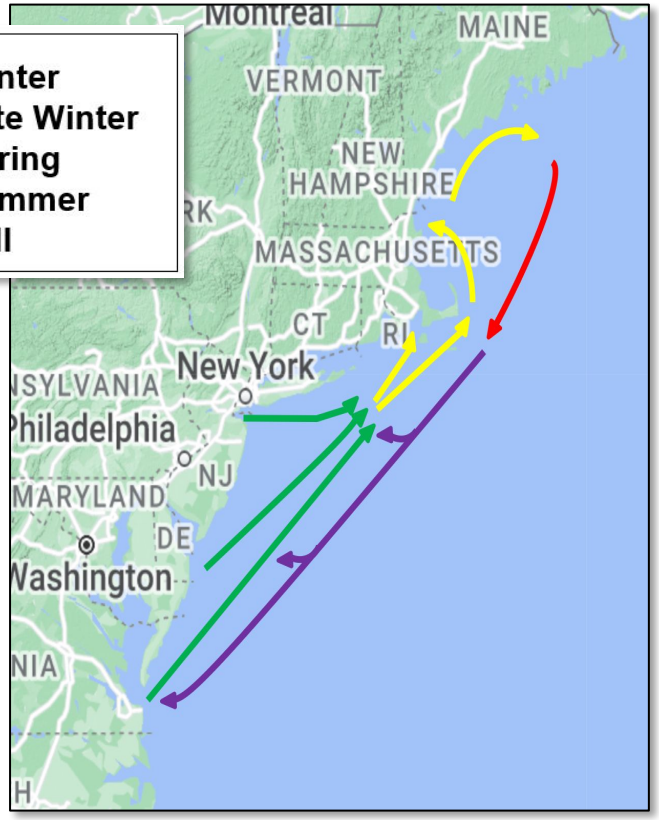
Declining Resident Striped Bass Abundance



- 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)*

Seasonal Movement of Migratory Striped Bass





Migratory Striped Bass

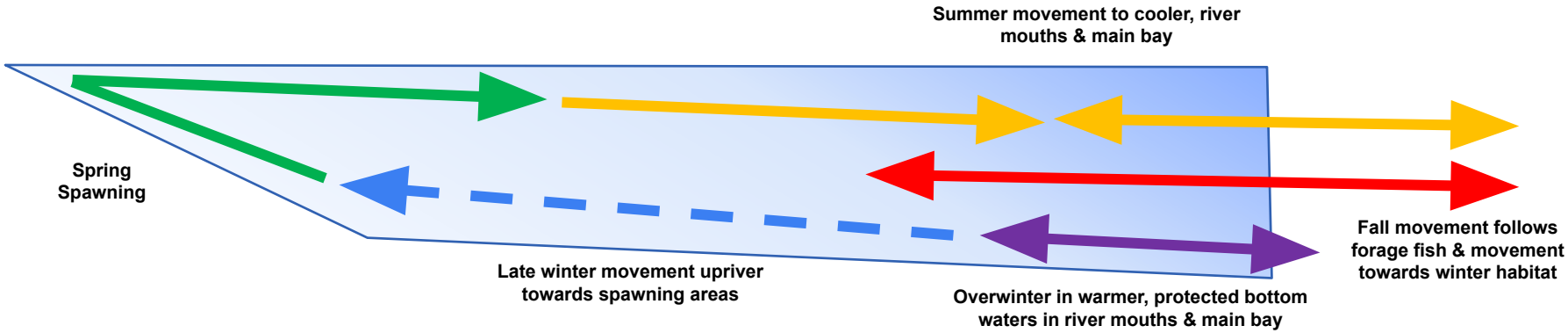
- Mostly females at least 4-8 years old (~23” to 30” and larger to ~50”) join the coastal migratory stock
- Leave Bay by summer and don’t return until mid-winter/early spring
- Larger than resident fish

Seasonal Movement of Resident Striped Bass

Resident Striped Bass

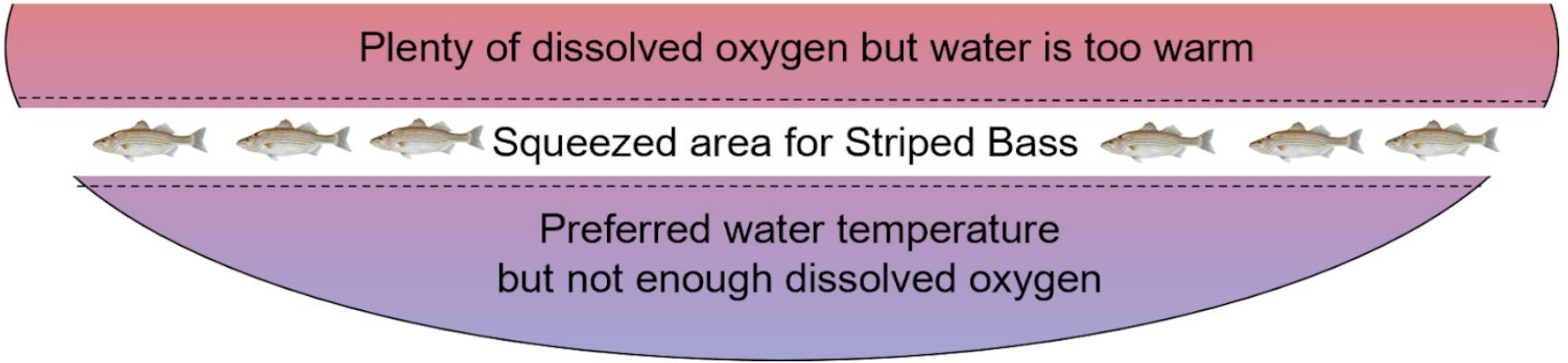
- After spawning, most males, some immature females, and a few mature females stay in Maryland waters.
- Most fish are < 6 years old and < 29” (4 - 5.5 lbs)
- Year-round population providing Maryland’s major recreational and commercial fishery.
- Commercial and recreational minimum size is 18” and 19”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

Winter
Late Winter
Spring
Summer
Fall



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.



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**

Changing Summer Location of Resident Striped Bass

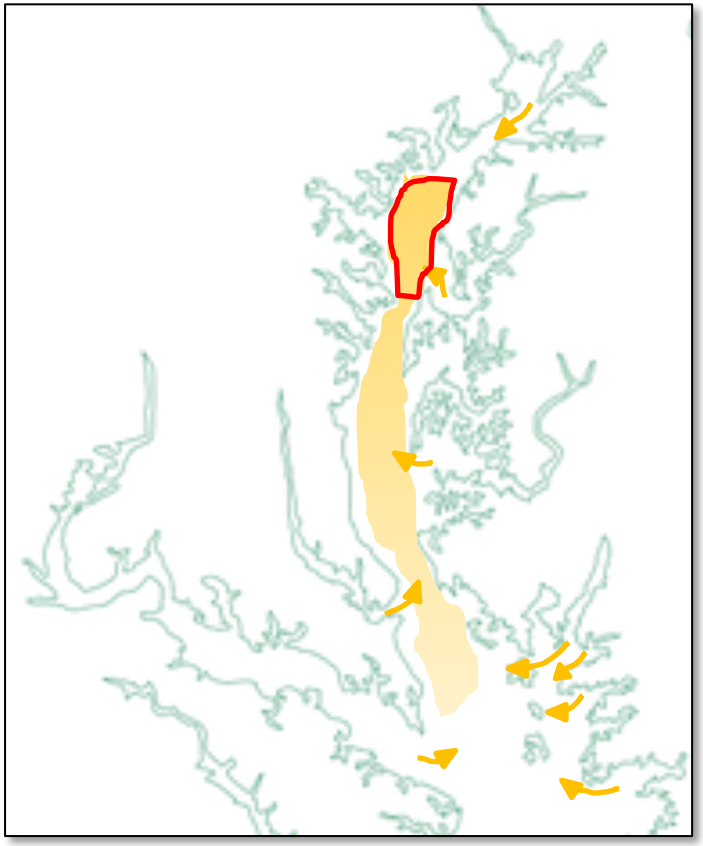
Concentration of Summer Resident Striped Bass

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



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

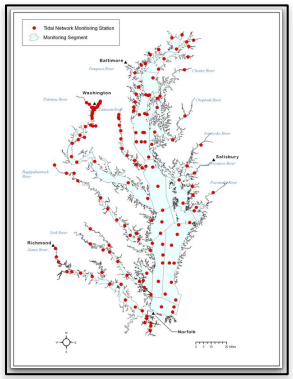
Suitable - Supports "normal" occupancy and growth potential
DO ≥4 mg/l, WT ≤82.4°F (28°C)

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°F(28°C) & ≤84.2°F (29°C)

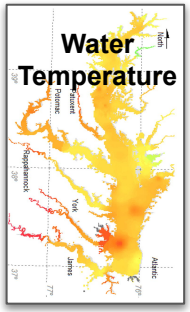
Marginal - Supports occupancy for a short period with little or no growth potential (Just passing through)
DO <3 mg/l & ≥2 mg/l, WT >84.2°F (29°C) & ≤86°F (30°C)

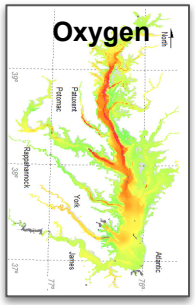
Unsuitable - Not suitable conditions experiencing either hypoxia or excess water temperature
DO <2 mg/l, WT >86°F (30°C)

Assessing Baywide Striped Bass Habitat Conditions

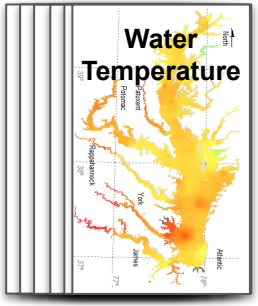


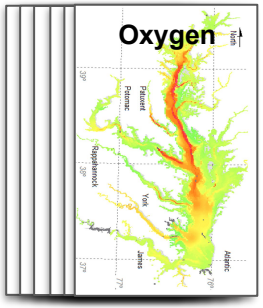
Compile Bay data from each cruise at 165 stations from 1986 to 2020



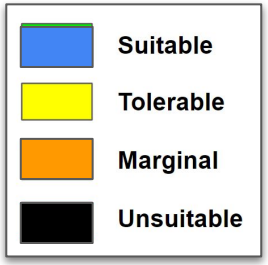


By cruise, interpolate data to create 3D Bay for Oxygen & Water Temperature

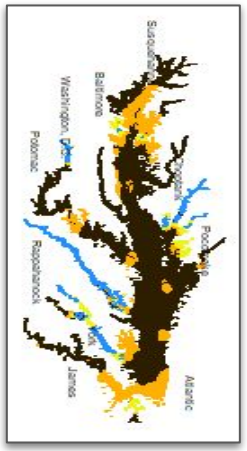




Repeat for each of the 509 cruises



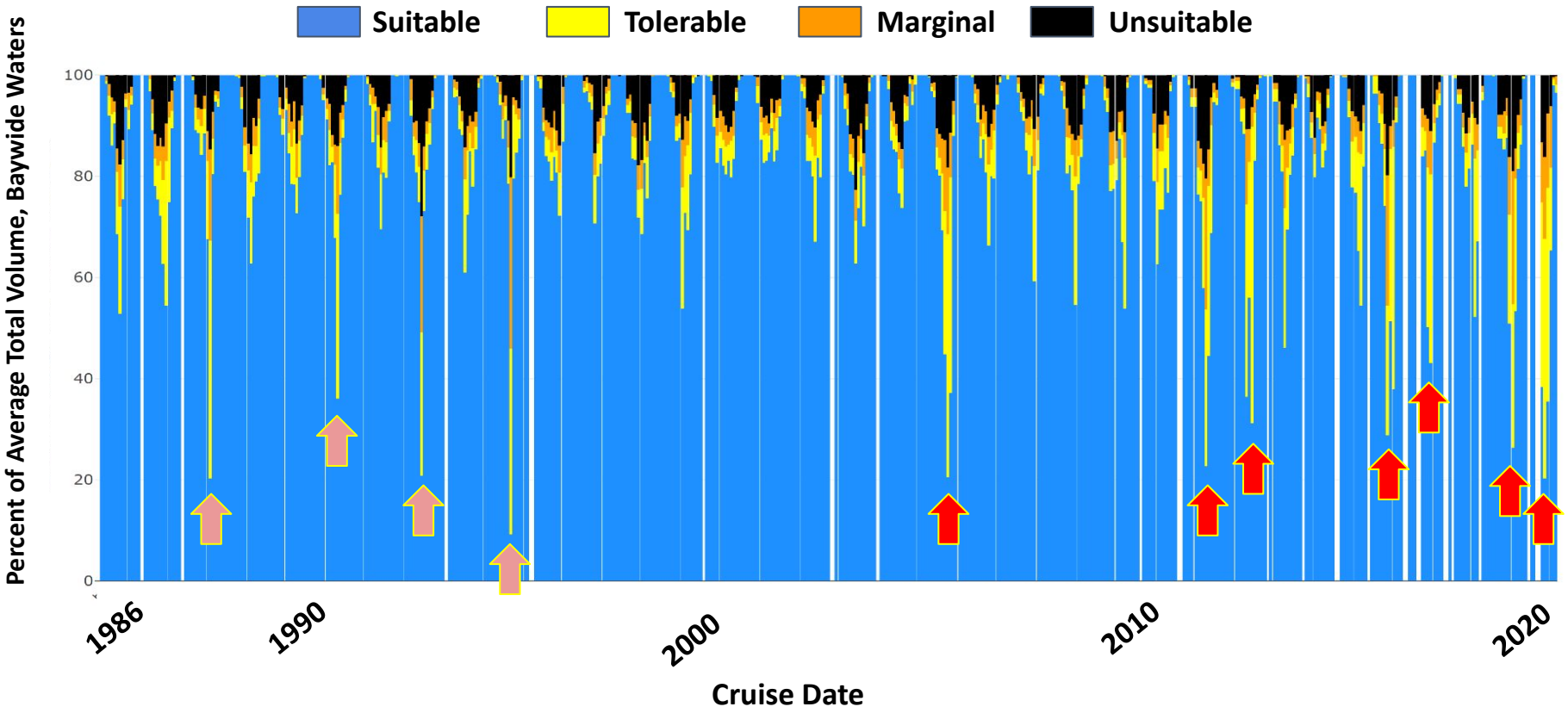
Apply Striped Bass Habitat Thresholds



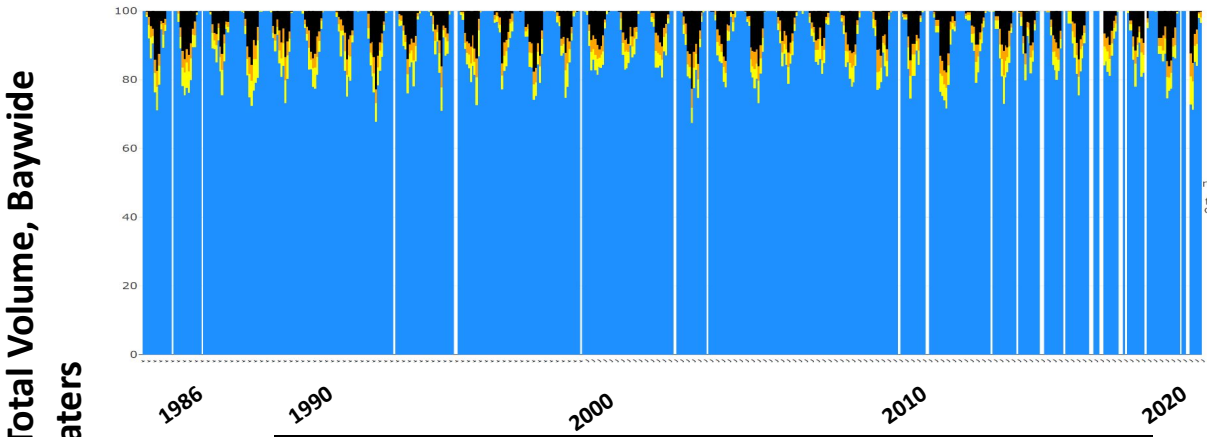
Assess Striped Bass Habitat

How have Baywide Striped Bass habitat conditions changed since 1986?

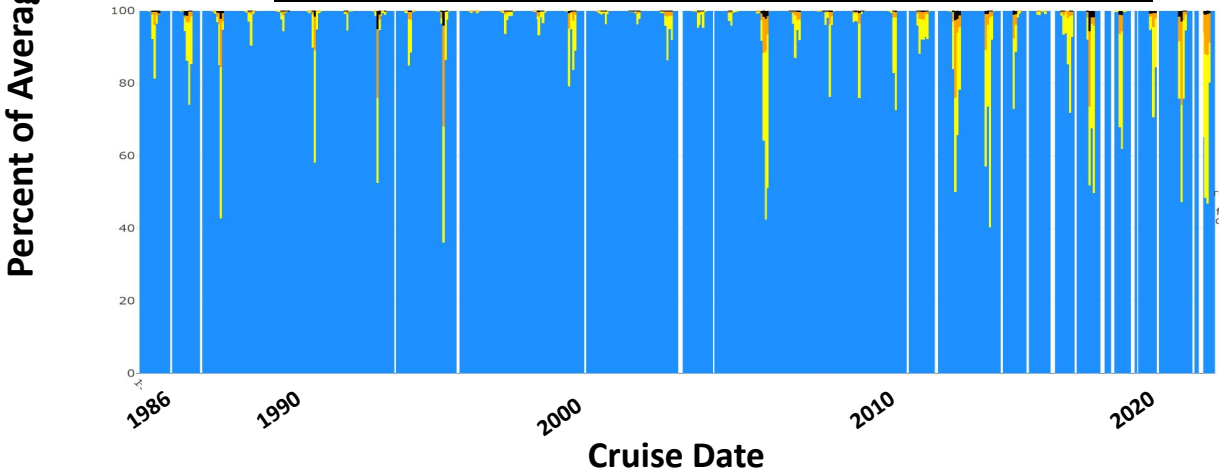
Baywide Striped Bass Habitat Conditions



Striped Bass Dissolved Oxygen Conditions



Striped Bass Water Temperature Conditions



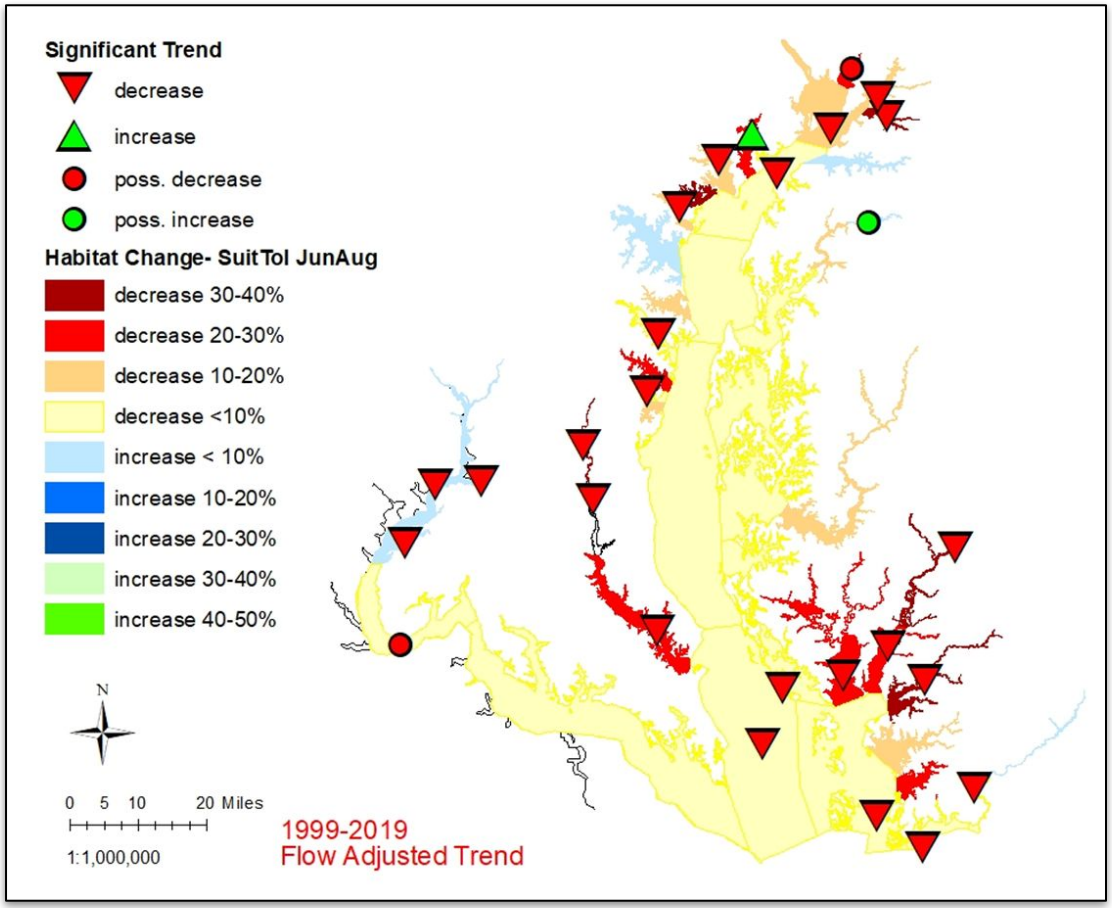
Oxygen Summary

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

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

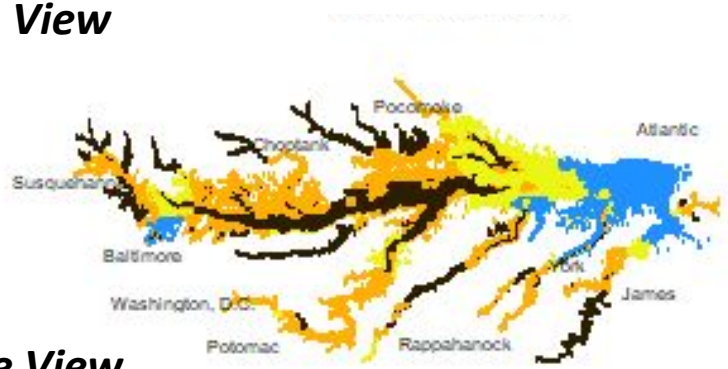
While primarily due to increasing water temperatures,there is evidence of degrading dissolved oxygen conditions 3m-8m in CB3MH, CB4M & EASMH

Episodic Chesapeake Bay Striped Bass Habitat Conditions

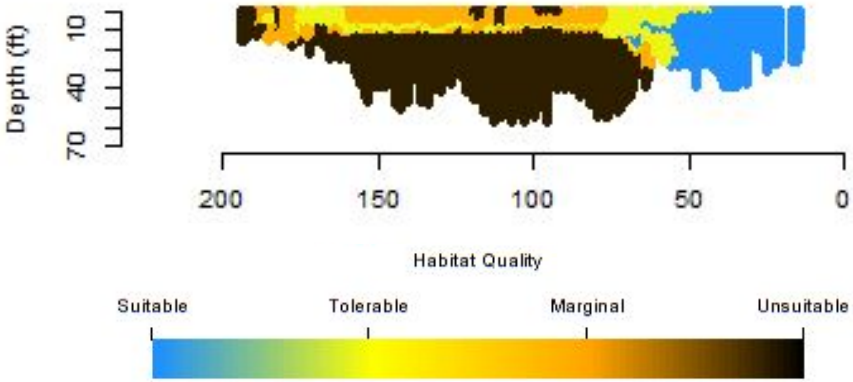
Example – July 15-31, 2019

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

Top View

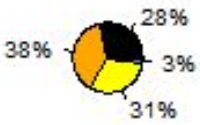


Side View

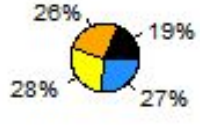


Suitable - Supports "normal" long-term occupancy with growth potential
Tolerable - Supports occupancy for a modest period of time, ~ 1 month, with limited or negative growth potential
Marginal - Supports very brief occupancy with little impact on growth potential
Unsuitable - Does not support occupancy

Habitat Quality (%)



Maryland

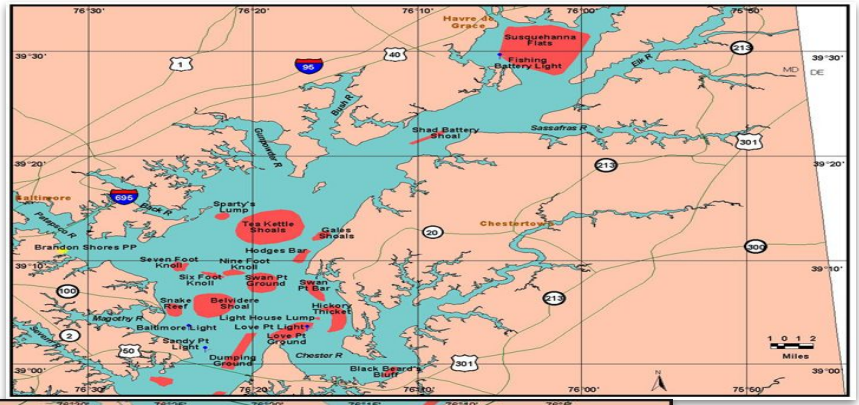


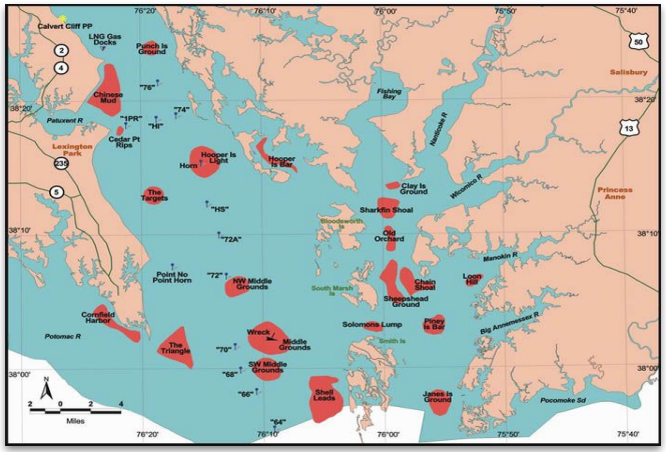
Baywide

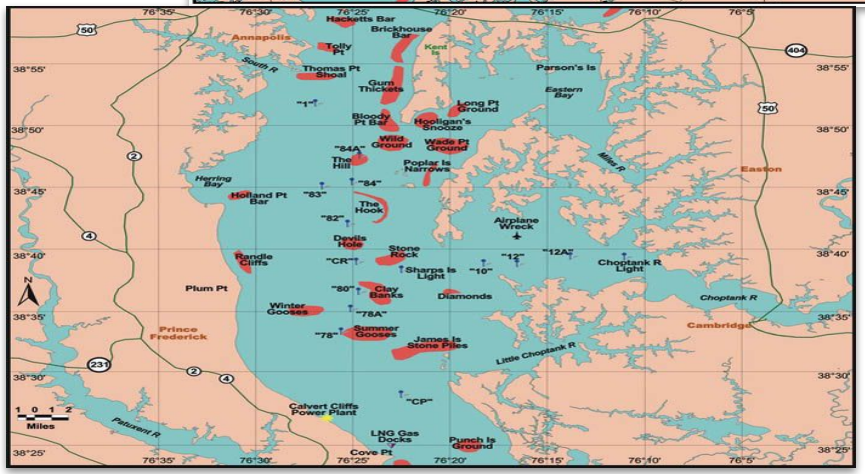
How have Baywide Striped Bass habitat conditions in prime fishing areas changed since 1986?

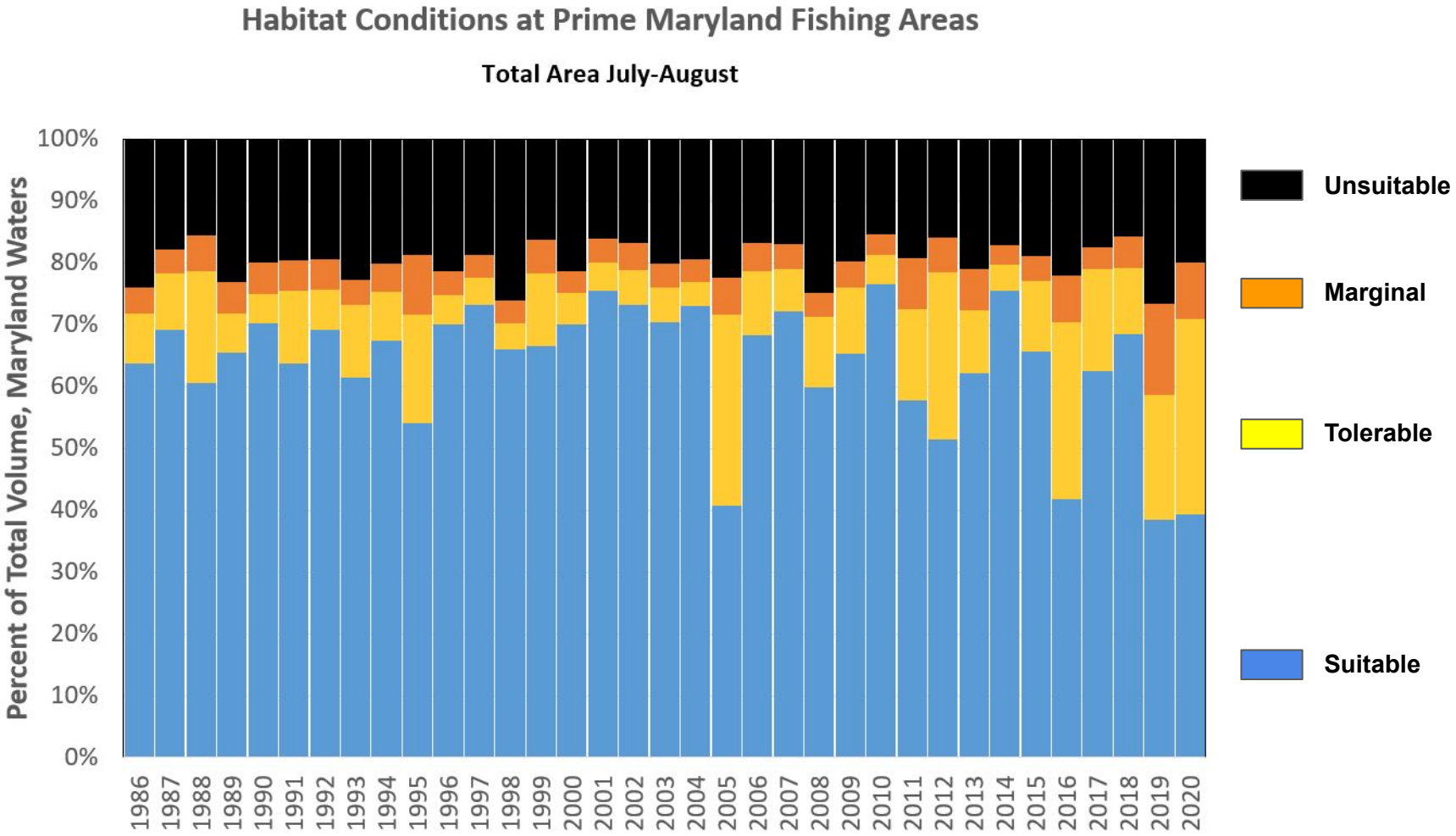
Prime Maryland Fishing Areas

These prime fishing areas are where fish congregate

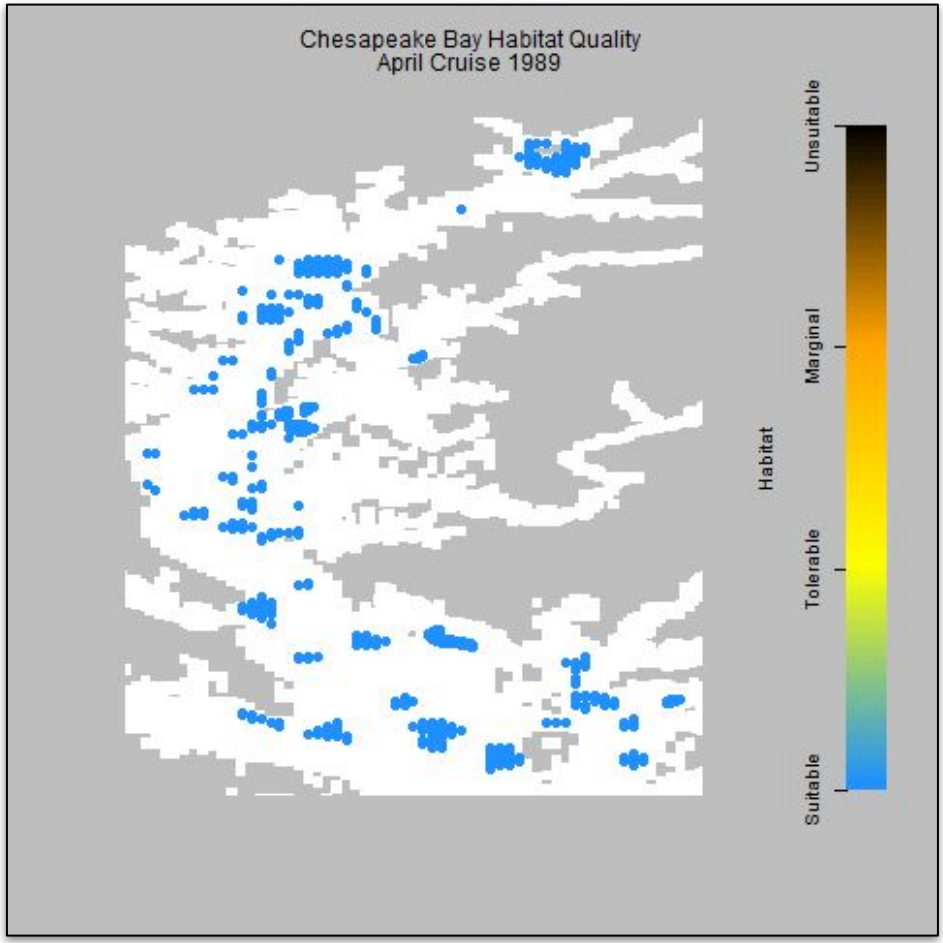







Habitat Conditions at Prime Maryland Fishing Areas
Total Area July-August
Percent of Total Volume, Maryland Waters
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Unsuitable
Marginal
Tolerable
Suitable

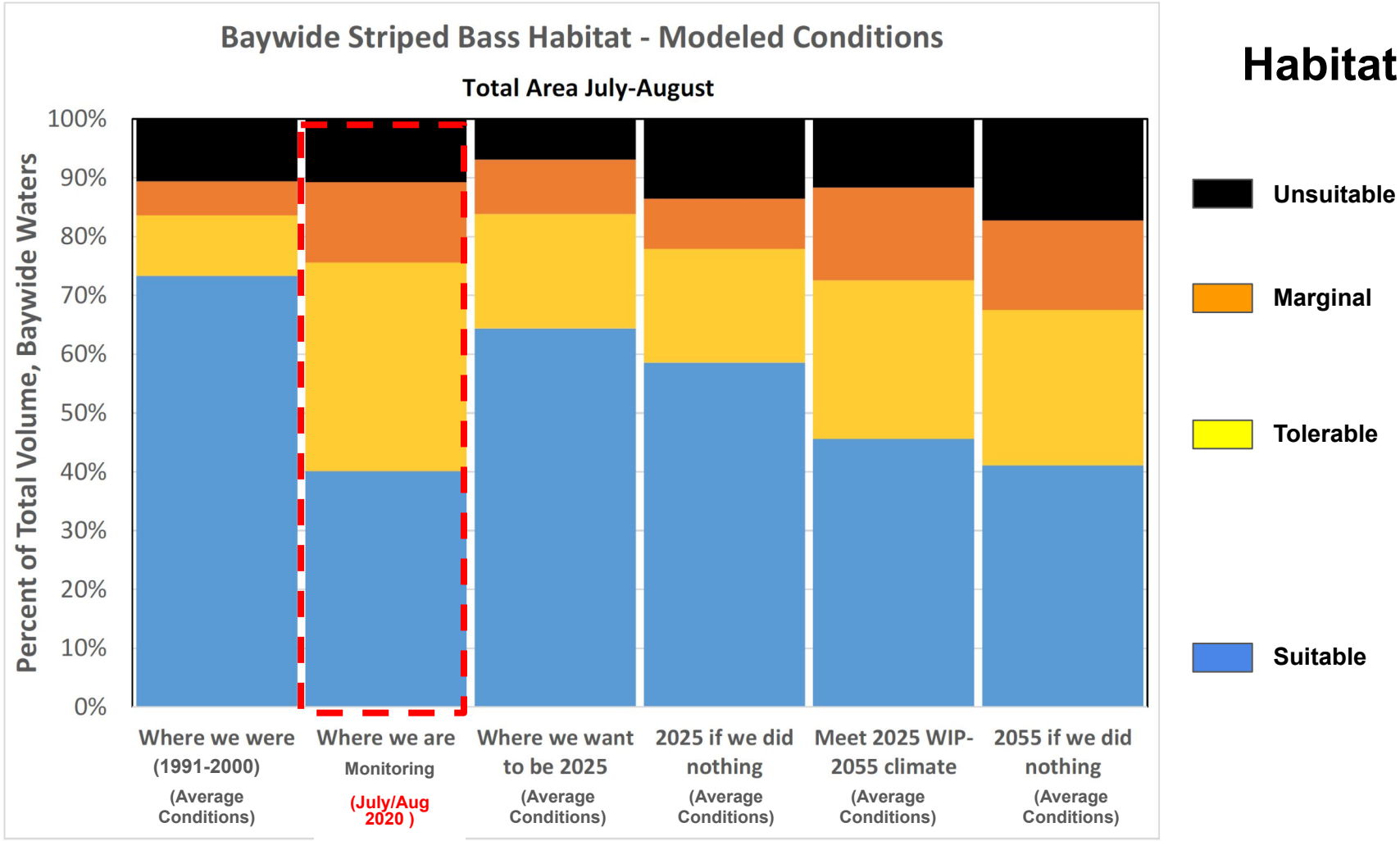
Typical Monthly Striped Bass Habitat Conditions at Prime Fishing Areas

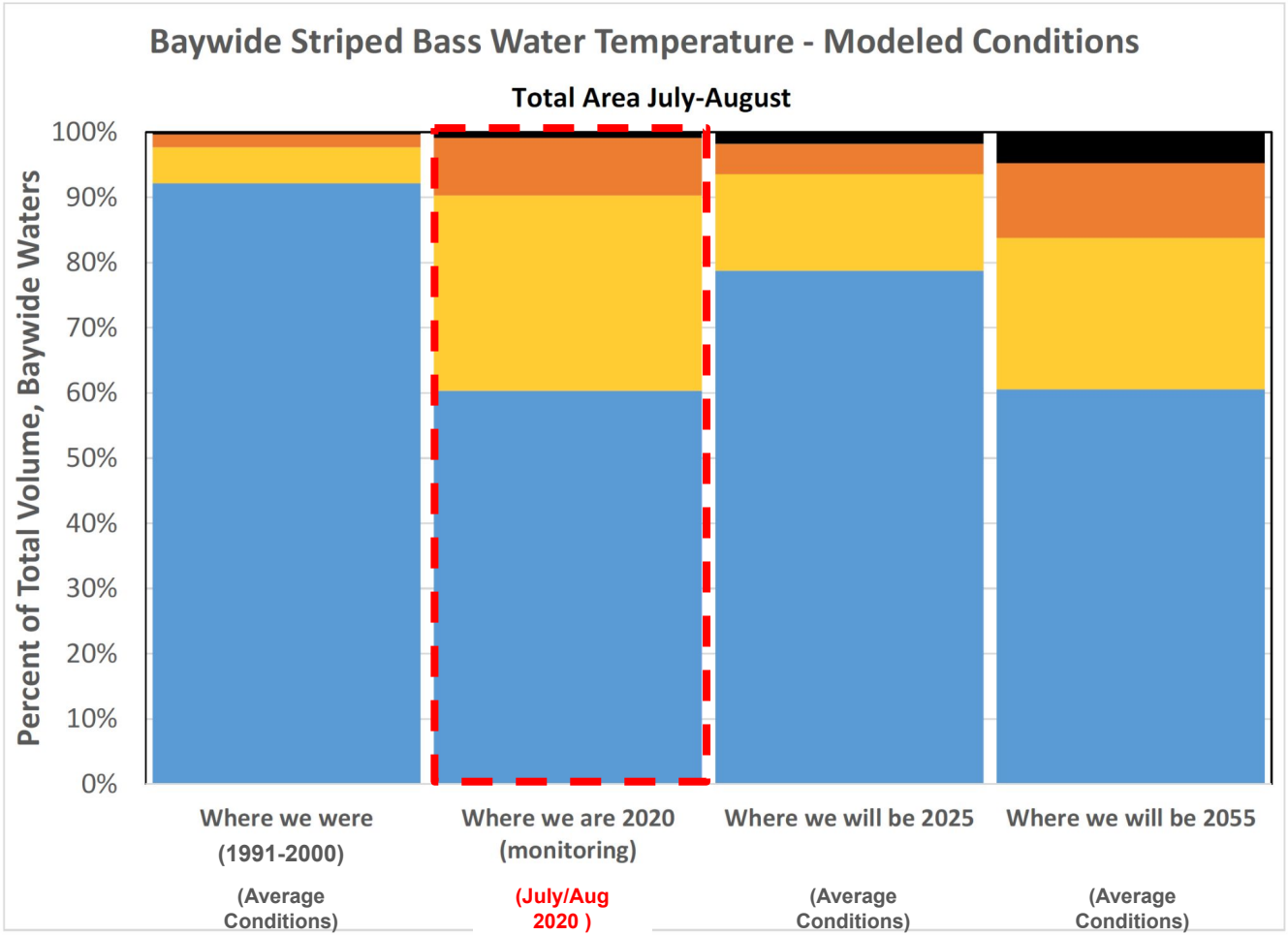


Summary

- 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

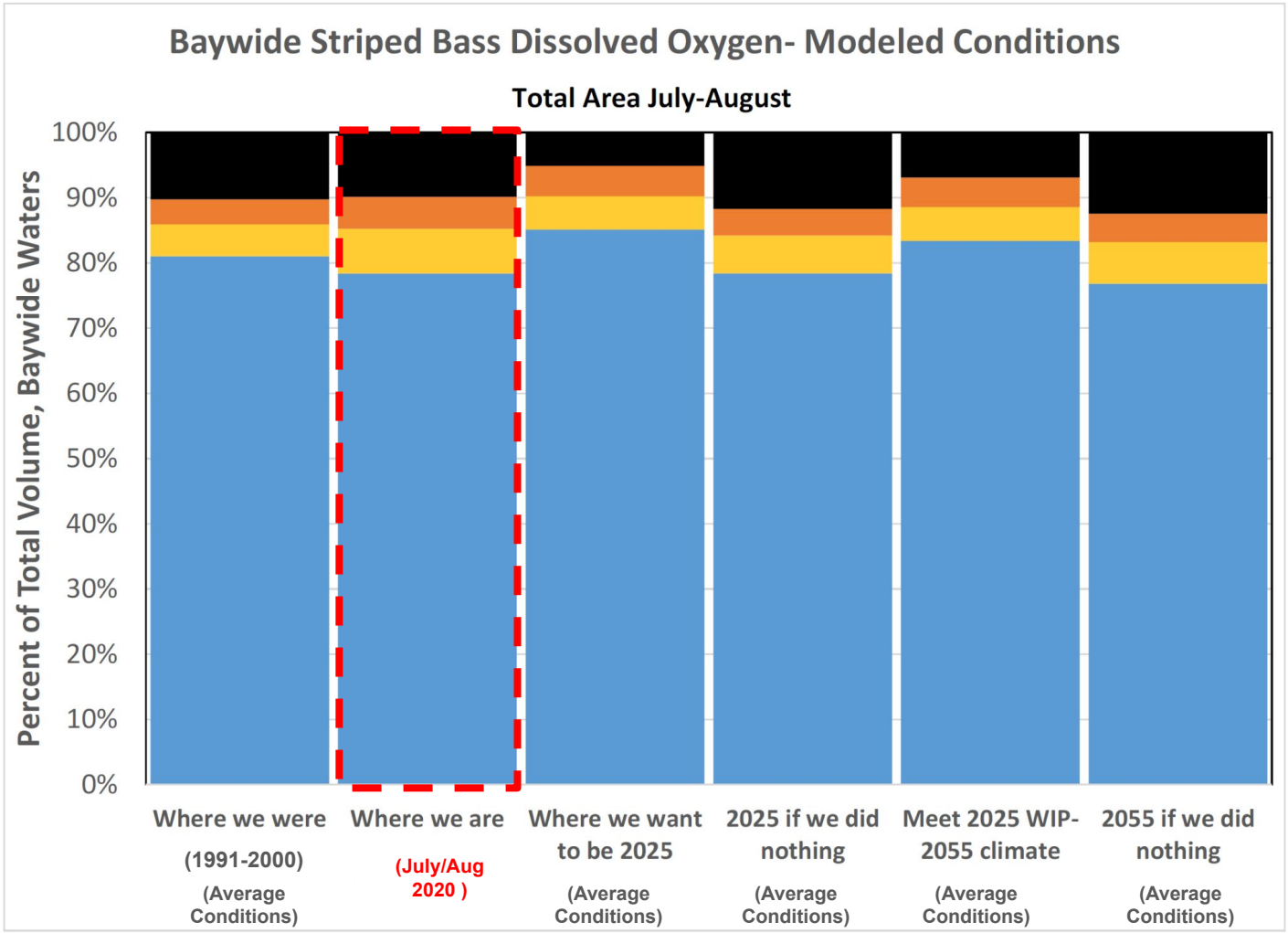
What is impact to striped bass habitat volume by meeting nutrient and sediment reduction goals?

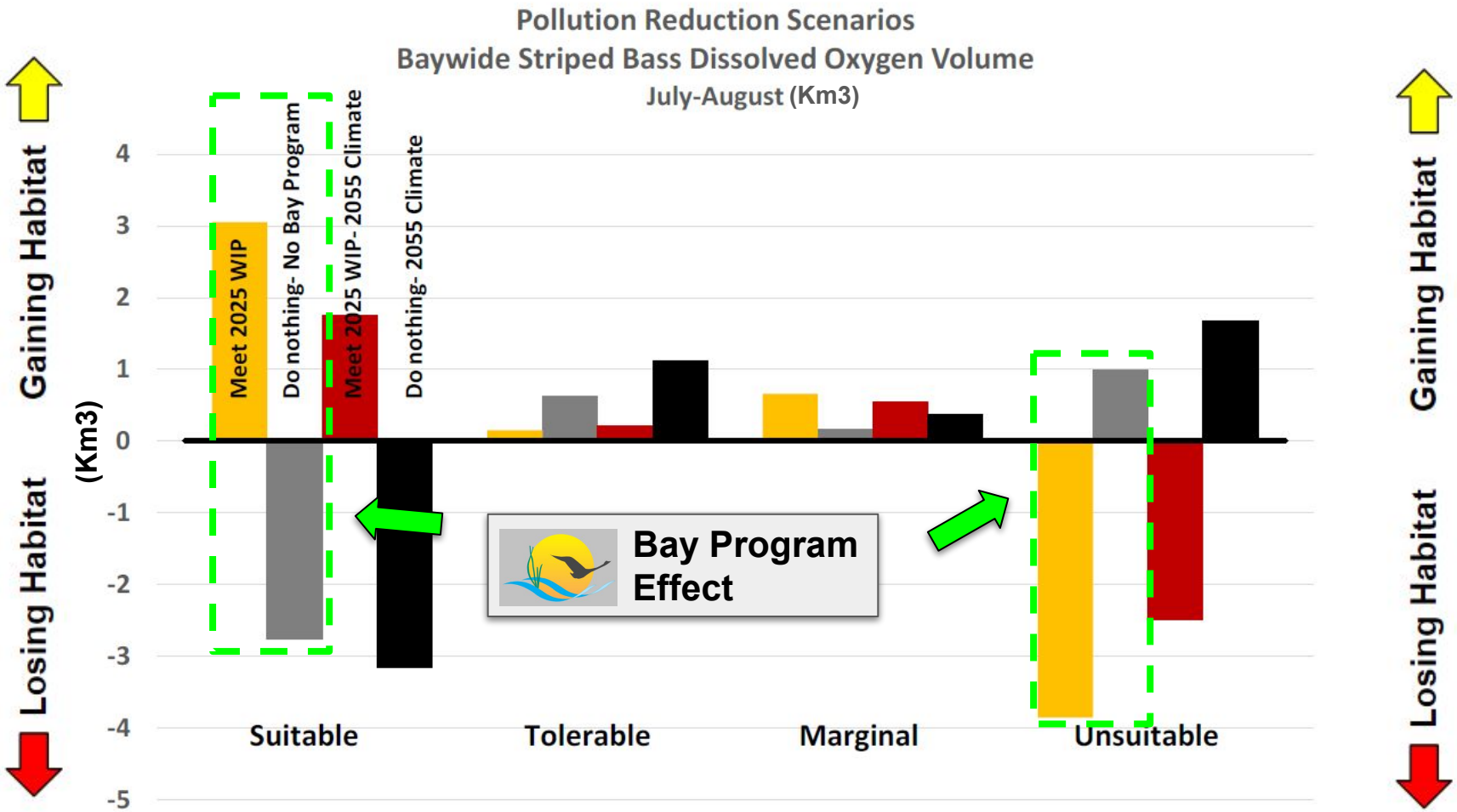

Baywide Striped Bass Habitat - Modeled Conditions
Total Area July-August
Percent of Total Volume, Baywide Waters
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Where we were (1991-2000) (Average Conditions)
Where we are Monitoring (July/Aug 2020)
Where we want to be 2025 (Average Conditions)
2025 if we did nothing (Average Conditions)
Meet 2025 WIP-2055 climate (Average Conditions)
2055 if we did nothing (Average Conditions)
Habitat
Unsuitable
Marginal
Tolerable
Suitable

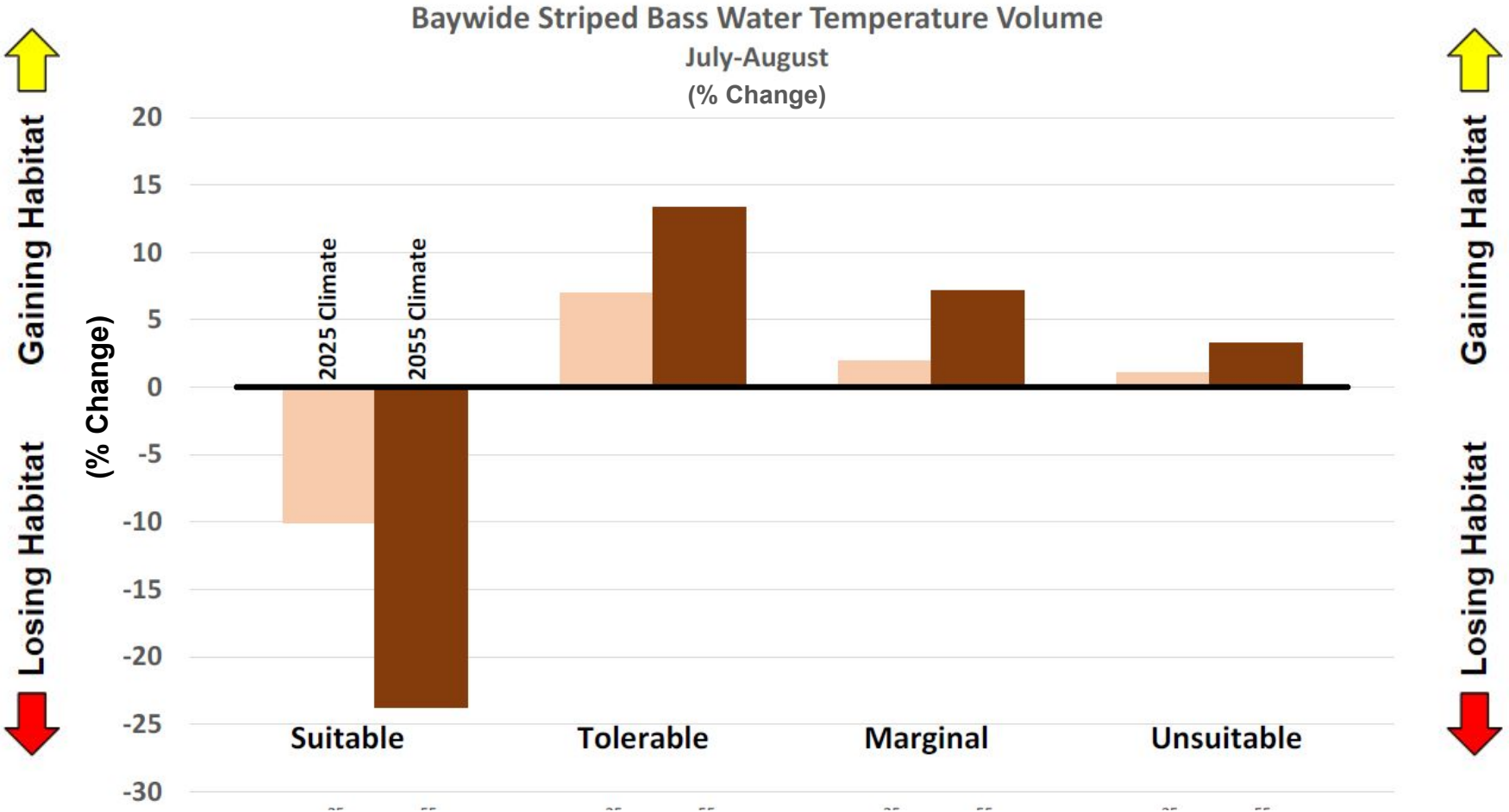


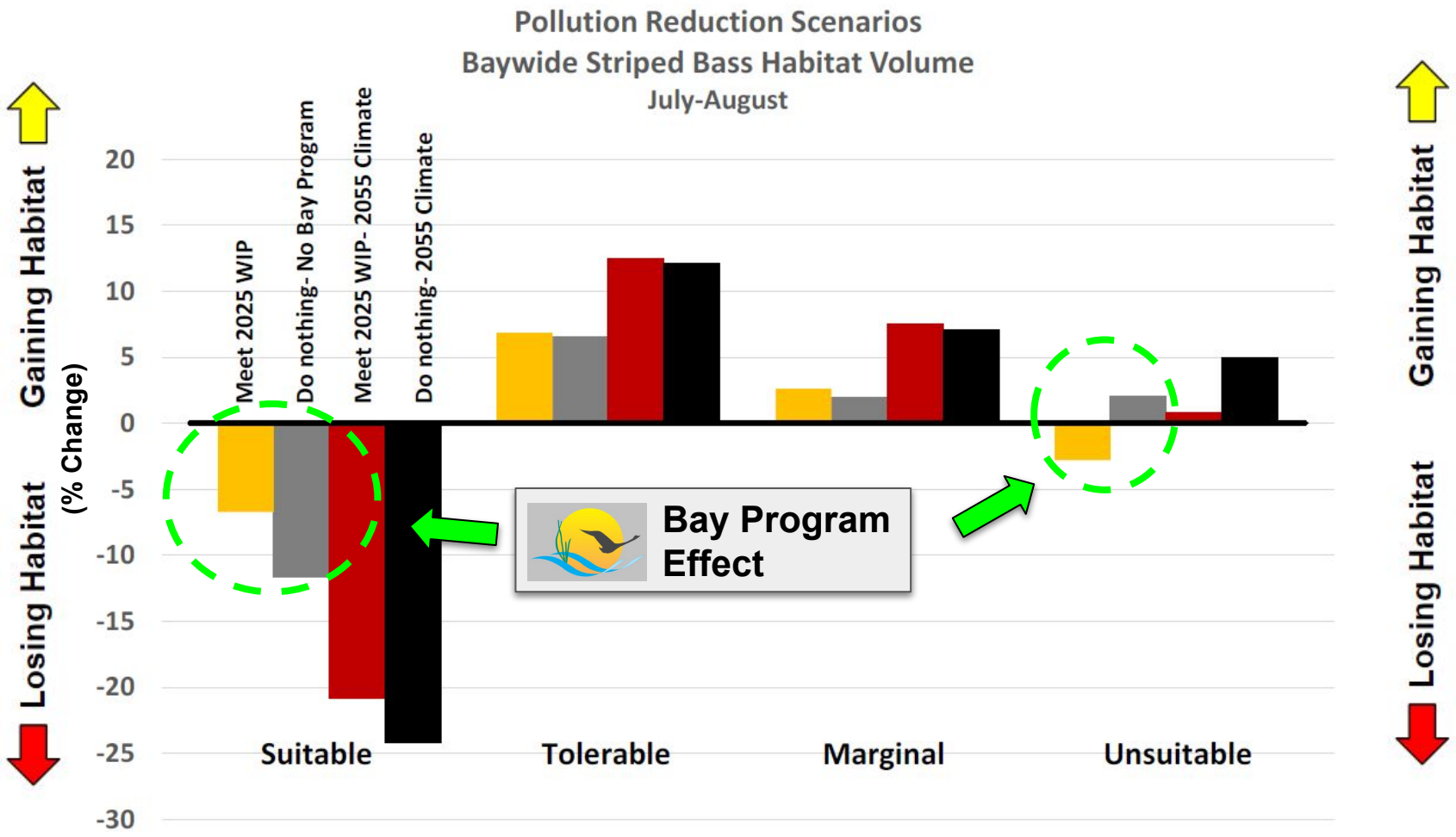
Water Temperature

- Unsuitable
- Marginal
- Tolerable
- Suitable


Baywide Striped Bass Dissolved Oxygen- Modeled Conditions
Total Area July-August
Percent of Total Volume, Baywide Waters
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Where we were
(1991-2000)
(Average Conditions)
Where we are
(July/Aug 2020)
Where we want to be 2025
(Average Conditions)
2025 if we did nothing
(Average Conditions)
Meet 2025 WIP-2055 climate
(Average Conditions)
2055 if we did nothing
(Average Conditions)
Dissolved Oxygen
Unsuitable
Marginal
Tolerable
Suitable


Pollution Reduction Scenarios
Baywide Striped Bass Dissolved Oxygen Volume
July-August (Km3)
Gaining Habitat
Losing Habitat
(Km3)
4
3
2
1
0
-1
-2
-3
-4
-5
Meet 2025 WIP
Do nothing- No Bay Program
Meet 2025 WIP- 2055 Climate
Do nothing- 2055 Climate
Bay Program Effect
Suitable
Tolerable
Marginal
Unsuitable
Gaining Habitat
Losing Habitat


Baywide Striped Bass Water Temperature Volume
July-August
(% Change)
Gaining Habitat
Losing Habitat
(% Change)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
2025 Climate
2055 Climate
Suitable
Tolerable
Marginal
Unsuitable
Gaining Habitat
Losing Habitat


Pollution Reduction Scenarios
Baywide Striped Bass Habitat Volume
July-August
Gaining Habitat
(% Change)
Losing Habitat
Meet 2025 WIP
Do nothing- No Bay Program
Meet 2025 WIP- 2055 Climate
Do nothing- 2055 Climate
20
15
10
5
0
-5
-10
-15
-20
-25
-30
Suitable
Tolerable
Marginal
Unsuitable
Bay Program Effect
Gaining Habitat
Losing Habitat

What is Baywide impact to oxygenated striped bass habitat to meeting nutrient and sediment reduction goals?

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

- Gained 5.7% (3.5 km^3) of volume with suitable oxygen, and reduced the amount of unsuitable volume by 60.9% (3.9km^3)

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

- Lost 4.0% (2.5 km^3) of volume with suitable oxygen but increased the amount of unsuitable volume by 23.3% (1.1 km^3).

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 km^3) suitable habitat volume; reduce unsuitable volume 52.8% (3km^3)

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

- Lose 17.1% (8.6 km^3) suitable habitat volume; increase unsuitable volume 29.2% (1.9 km^3).

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 km^3) suitable volume, lose 19% (0.3 km^3) 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 km^3) suitable volume; gain 55% (4 km^3) 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***