Assessing Climate Change & Summertime Resident Chesapeake Bay Striped Bass Habitat

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DEPARTMENT OF
NATURAL RESOURCES

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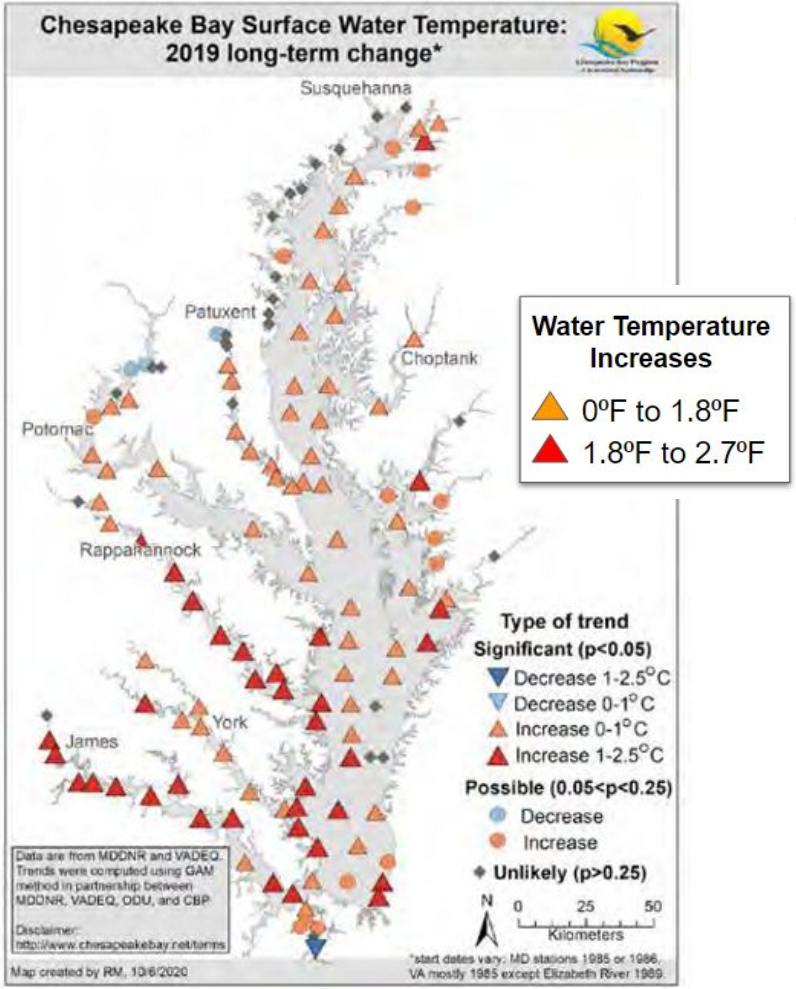


A Changing Chesapeake Bay

Climate Change Impacts

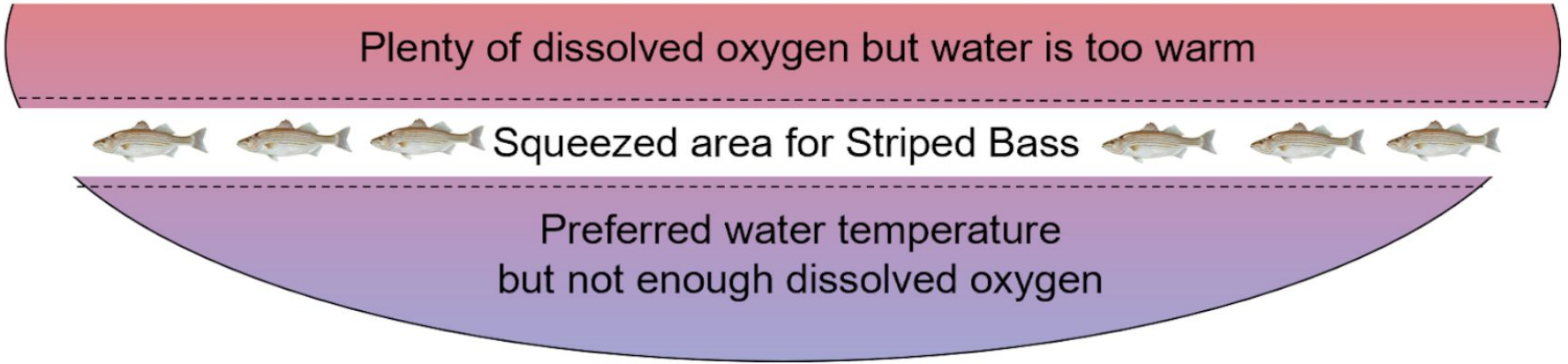
- Bay water temperature increasing over last three decades - Most Bay stations showing between 1° to 2°F increase since 1999. Increases are not consistent throughout water column (R. Murphy, 2020)
- Marine heat waves becoming more frequent in Bay waters *(Mazzini and Pianca, 2021)*

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.

Striped Bass Squeeze Hypothesis

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



Determining Summer Habitat Thresholds for Resident Striped Bass

- To assess habitat conditions, we needed to develop dissolved oxygen (DO) and water temperature requirements (WT) for “typical” harvestable resident fish during worst habitat conditions (June - August)
    - Smaller fish are more tolerant of poor water quality and larger fish are less tolerant
- We developed Chesapeake Bay specific requirements for resident striped bass using results from scientific literature: Bioenergetics models, direct observation, tagging, telemetry, and literature reviews.
    - Mostly studies were Bay specific with some SE reservoir studies
- Four habitat categories: Suitable, Tolerable, Marginal, and Unsuitable

Chesapeake Bay Striped Bass Thresholds for Dissolved Oxygen (DO) & Water Temperature (WT)

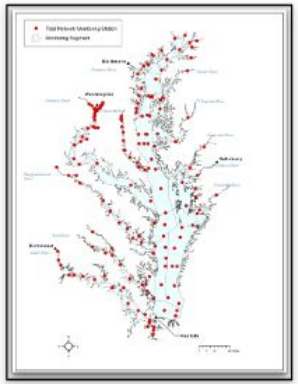
Suitable - Supports "normal" occupancy and growth potential, no mortality
DO ≥4 mg/l, WT ≤82.4°F (28°C)

Tolerable - Supports occupancy for a modest period of time with limited or negative growth potential, little or no mortality (~1 month)
DO <4 mg/l & ≥3 mg/l, WT >82.4°F(28°C) & ≤84.2°F (29°C)

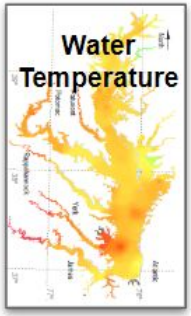
Marginal - Supports very brief occupancy with potential for high mortality beyond brief exposure (Just passing through)
DO <3 mg/l & ≥2 mg/l, WT >84.2°F (29°C) & ≤86°F (30°C)

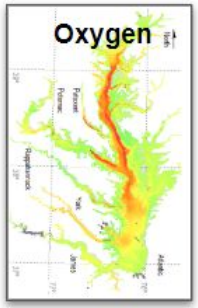
Unsuitable - Not suitable conditions experiencing either hypoxia or excess water temperature
DO <2 mg/l, WT >86°F (30°C)

Process for Assessing Maryland Striped Bass Habitat (DO and WT)

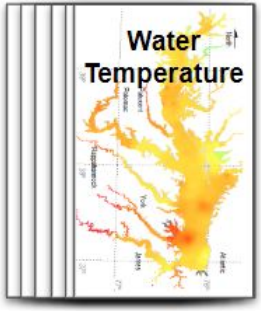


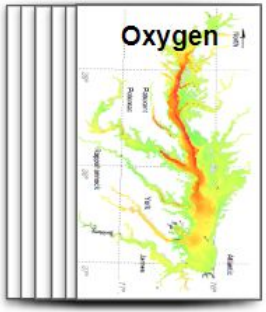
Compile Bay data from each cruise at 165 stations from 1986 to 2020





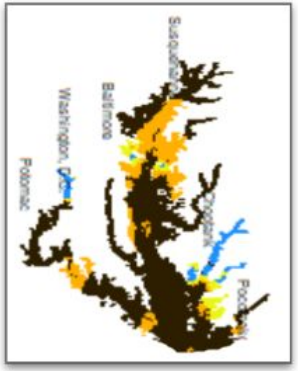
By cruise, interpolate data to create 3D Bay for Oxygen & Water Temperature





Repeat for each of the 509 cruises

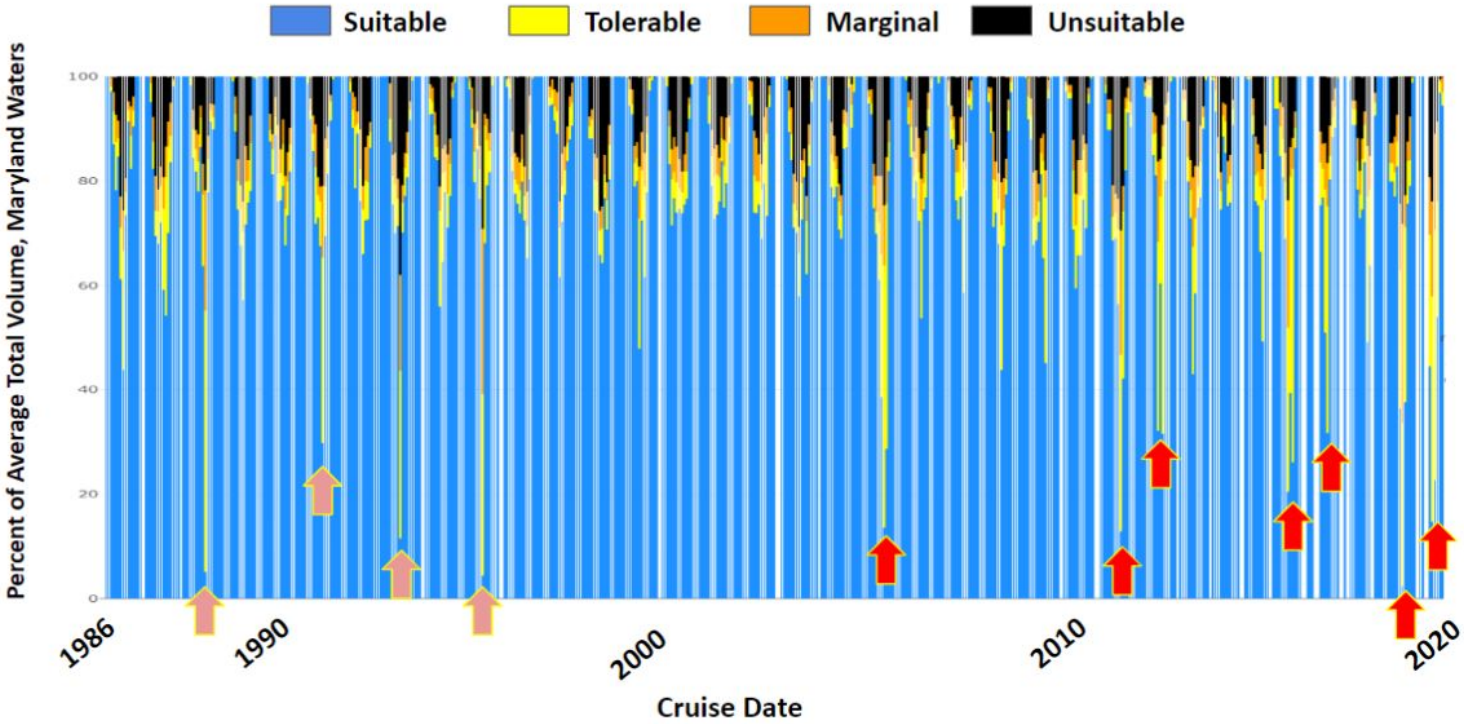
Apply Striped Bass Habitat Thresholds



Cut to Maryland Tidal Waters and then Assess Striped Bass Habitat

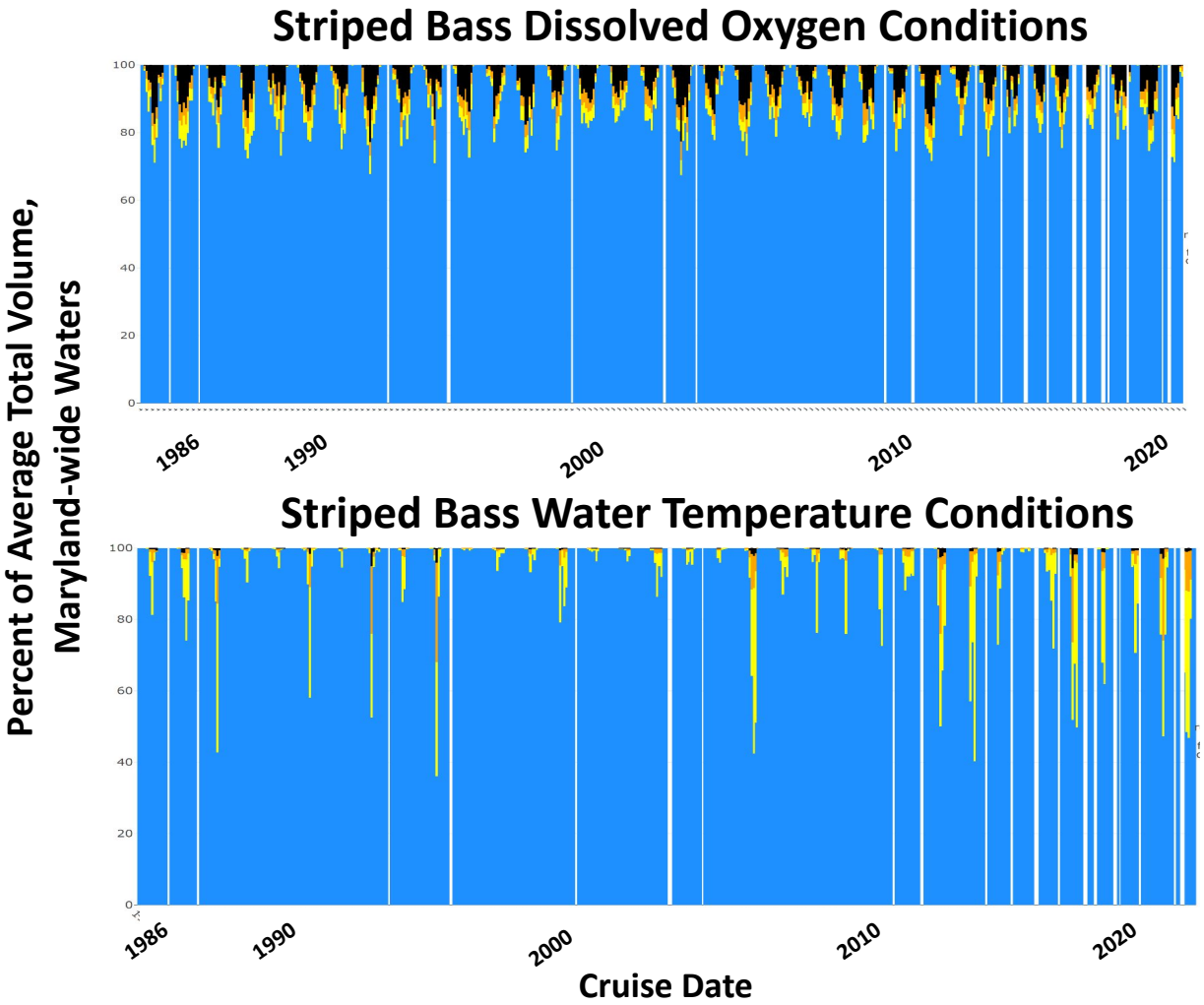
How have resident Striped Bass habitat conditions changed since 1986?

Maryland-wide Striped Bass Habitat Conditions



Single months of degraded conditions:1988, 1991, 1993, 1995

Consecutive months of degraded conditions: 2005, 2011, 2012, 2016, 2017, 2019, 2020



Oxygen Summary

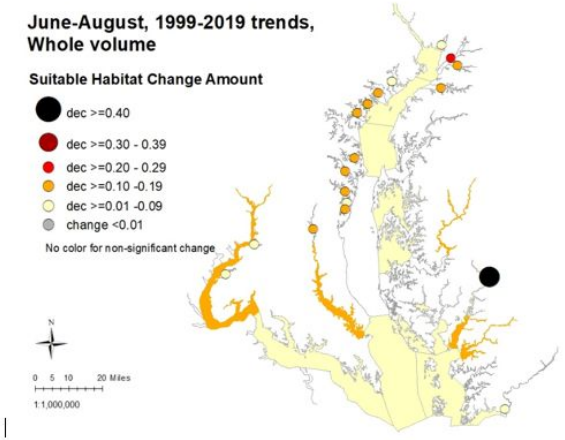
- Nutrient and Sediment reduction efforts have offset warming Bay waters and increasing populations to keep oxygen conditions stable
  - Warmer water holds less oxygen, more biological activity, stratification
  - Increases in watershed population: 1980-12.7M, 2017-18.4M

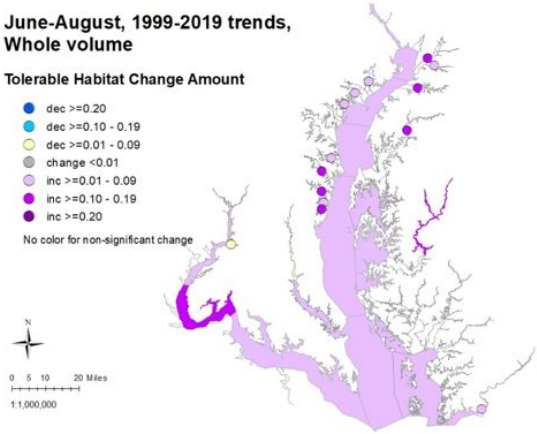
Water Temperature Summary

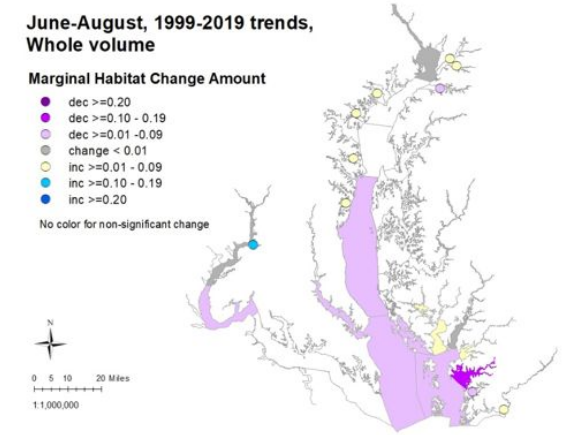
- Declining habitat conditions are primarily due to increasing water temperature

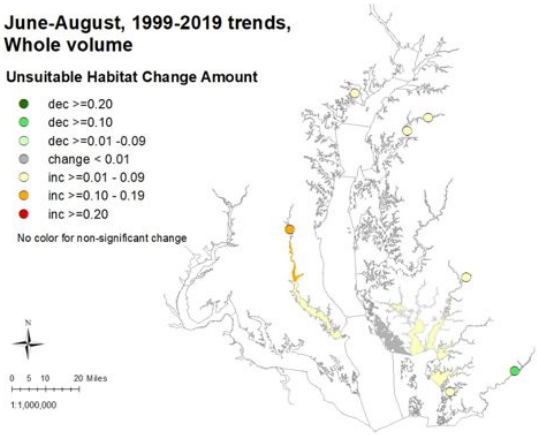
Habitat Quality Degrading

- Shifting from suitable towards Tolerable and Marginal habitat conditions







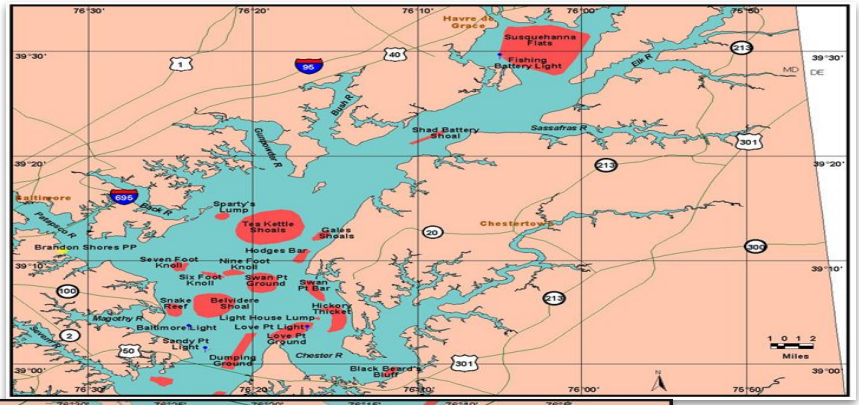


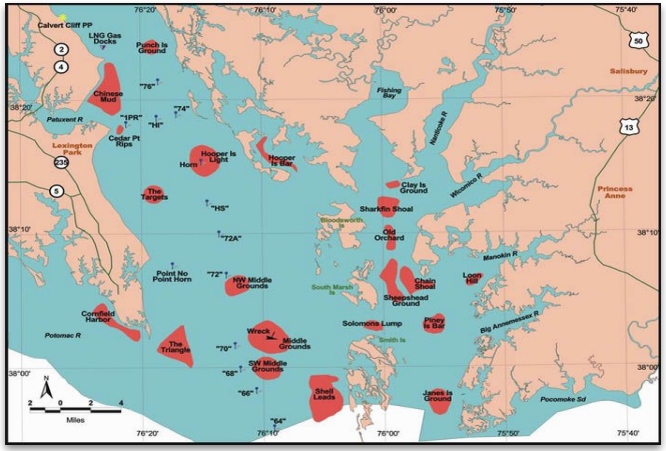
How have resident Striped Bass habitat conditions at popular fishing locations changed since 1986?

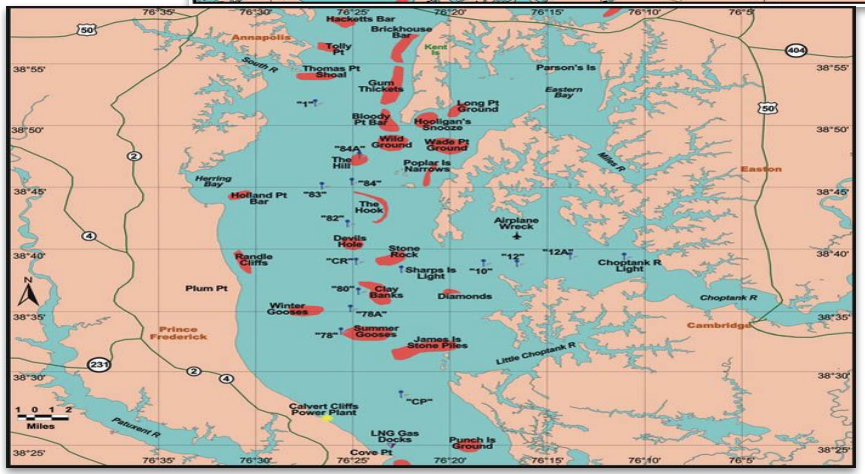
Popular Maryland Fishing Areas

These prime fishing areas are where fish congregate

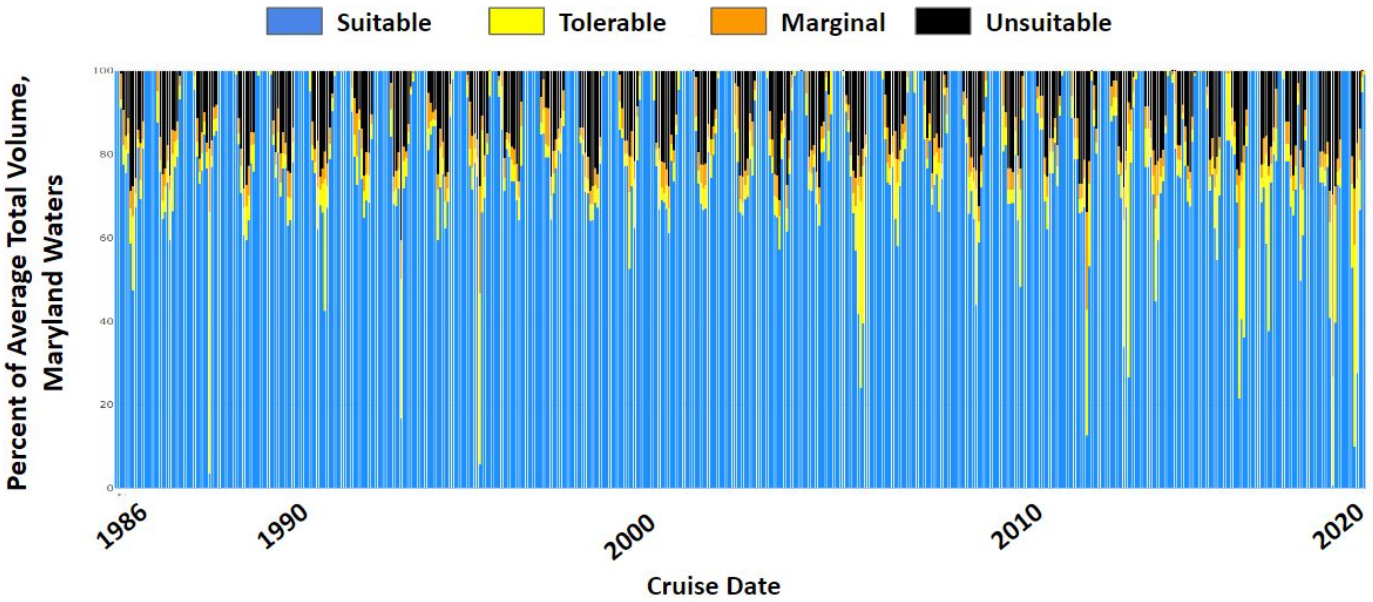
(Genovese, P. 2000)





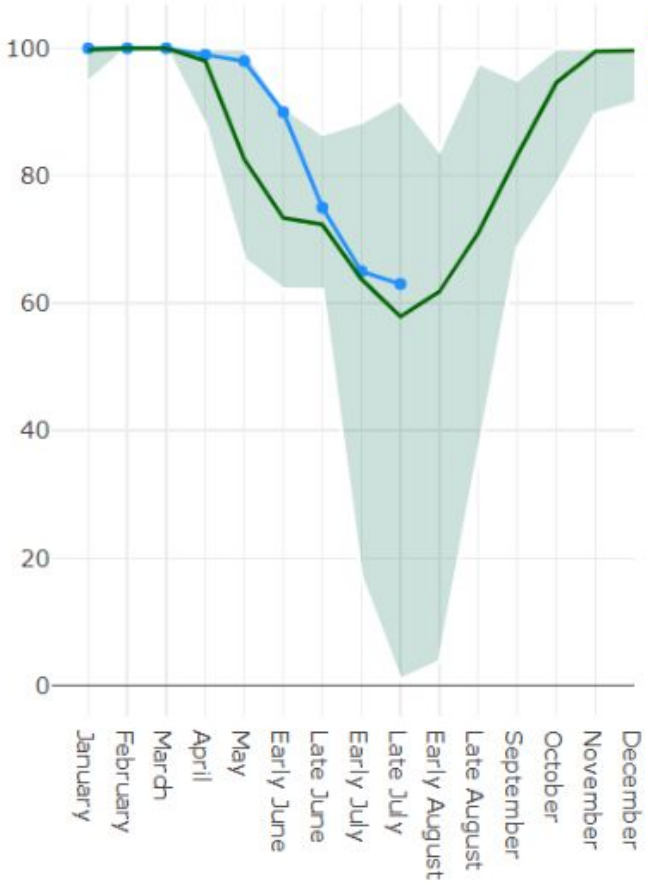


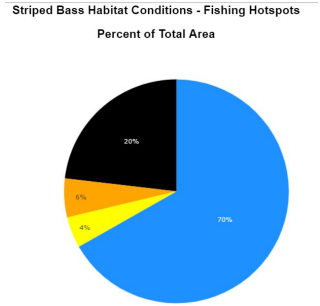
Habitat Conditions at Popular Maryland Fishing Areas



- Same pattern of increasing frequency and duration of degrading conditions
- Unsuitable Maryland-wide habitat is ~10% to 15%. At popular fishing areas, this increases to about 30% of total habitat

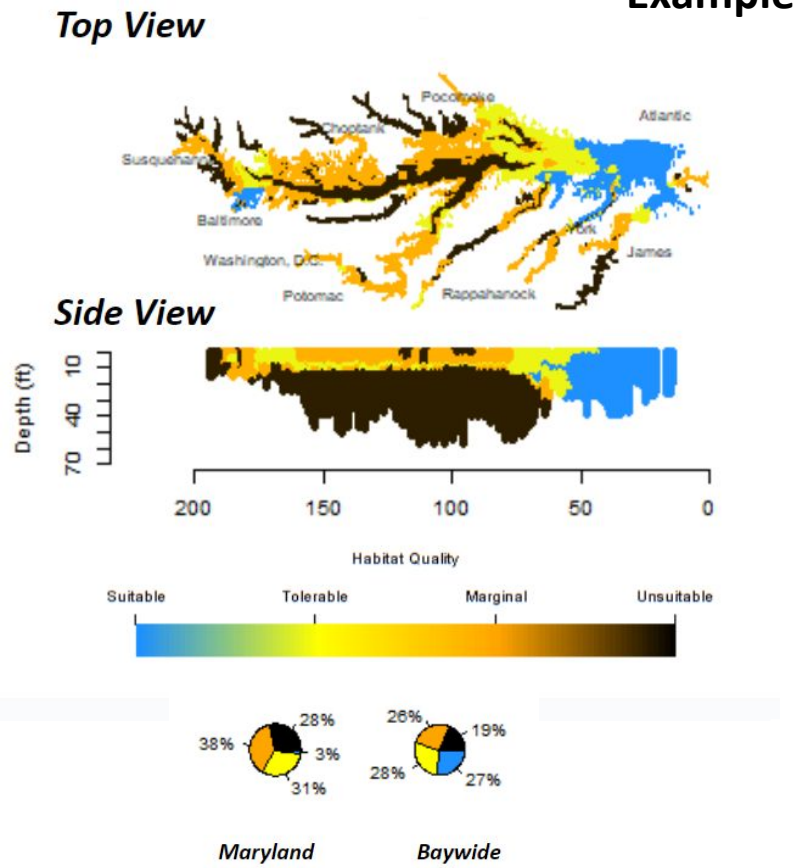
Striped Bass Habitat Conditions - Fishing Hotspots





Episodic Chesapeake Bay Striped Bass Habitat Conditions

Example – July 15-31, 2019



- While hypoxia can occur from May through September, there are periods of time in July and August where the warm water temperatures severely reduce the amount of suitable striped bass habitat
- During July 2019, the striped bass squeeze layer of suitable conditions is very visible (green band)
- Some variations are due to monitoring dates that can occur over a two-week period.
- Interpolator output allows us to quantify habitat volumes many ways (entire bay, by state, segment, river system)
- Here is an example of a type of communication product resulting from the application of the new WT and DO thresholds to Maryland DNR water monitoring data

Summary of Past & Present Conditions (1986-2019)

- Striped bass habitat has degraded since 1986, mostly in the last 10-20 years. In Maryland, Suitable habitat has decreased between 1% and 10%
- In popular 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

Future Conditions of Maryland Striped Bass Habitat

- We are working with Chesapeake Bay Program to examine changes in future striped bass habitat using various climate change and Bay cleanup scenarios
- The Chesapeake Bay fishery will likely experience more frequent, longer lasting and more degraded habitat conditions.
- 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.

*Special thanks to **Maryland DNR Resource Assessment Service & Fishing and Boating Service** Bay monitoring, data management, analysis and administrative folks*