Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay

Spring 2025 Seasonal Summary

Spring 2025 Headlines

- **Salinity remained above average through most of spring as a result of drier conditions in winter and early spring. Higher salinity supports oyster growth and reproduction.**
- **Hypoxia remained low compared with the early onset of hypoxia in spring 2024. This is good for crabs, oysters, and striped bass.**

Summary of Potential Impacts of Environmental Conditions on Species from Most Recent Four Seasons

	Summer 2024	Fall 2024	Winter 2024–25	Spring 2025
Striped Bass	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	**WT, DO, Sal, Flow**
Blue Crabs	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	**WT, DO, Sal, Flow**
Oysters	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	**WT, DO, Sal, Flow**
Bay Anchovy	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	**WT, DO, Sal, Flow**
Summer Flounder	WT, DO, Sal, Flow	WT, DO, Sal, Flow	WT, DO, Sal, Flow	**WT, DO, Sal, Flow**

WT = Water Temperature
Sal = Salinity
Flow = Streamflow
DO = Dissolved Oxygen

Green = Potentially positive impact
Red = Potentially negative impact
Black = Neutral or unknown impact

Purpose

The National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Office (NCBO) develops seasonal summaries of water-quality parameters in the Chesapeake Bay to provide fisheries managers and the public information about recent environmental conditions, how they compare with long-term averages, and how these conditions might affect key fishery resources such as striped bass (*Morone saxatilis*), blue crab (*Callinectes sapidus*), eastern oysters (*Crassostrea virginica*), and summer flounder (*Paralichthys dentatus*). The intent is to provide information linking changes in environmental conditions to potential effects on living resources that can inform ecosystem-based management at state and regional levels. The seasons are defined as winter (December–February), spring (March–May), summer (June–August), and fall (September–November).

The primary data sources for these seasonal summaries are the NOAA Chesapeake Bay Interpretive Buoy System (CBIBS) for real-time, surface water temperature and salinity information at four locations throughout the Chesapeake Bay (Figure 1); the NOAA CoastWatch Program for Bay-wide, satellite-based sea surface temperature (SST) anomalies; the NOAA National Weather Service PREcipitation Summary and Temperature Observations (PRESTO) reports for regional precipitation and air temperature information; the National Centers for Environmental Information for precipitation data; and the U.S. Geological Survey (USGS) National Water Information System for local streamflow information at various locations throughout the Bay. In summer, the Chesapeake Bay Environmental Forecast System (CBEFS) provides estimates of the volume and duration of seasonal hypoxia. NCBO uses these seasonal summaries to develop an annual synthesis for inclusion in the Mid-Atlantic State of the Ecosystem Report, which is developed by the Northeast Fisheries Science Center and presented to the Mid-Atlantic Fishery Management Council each year.

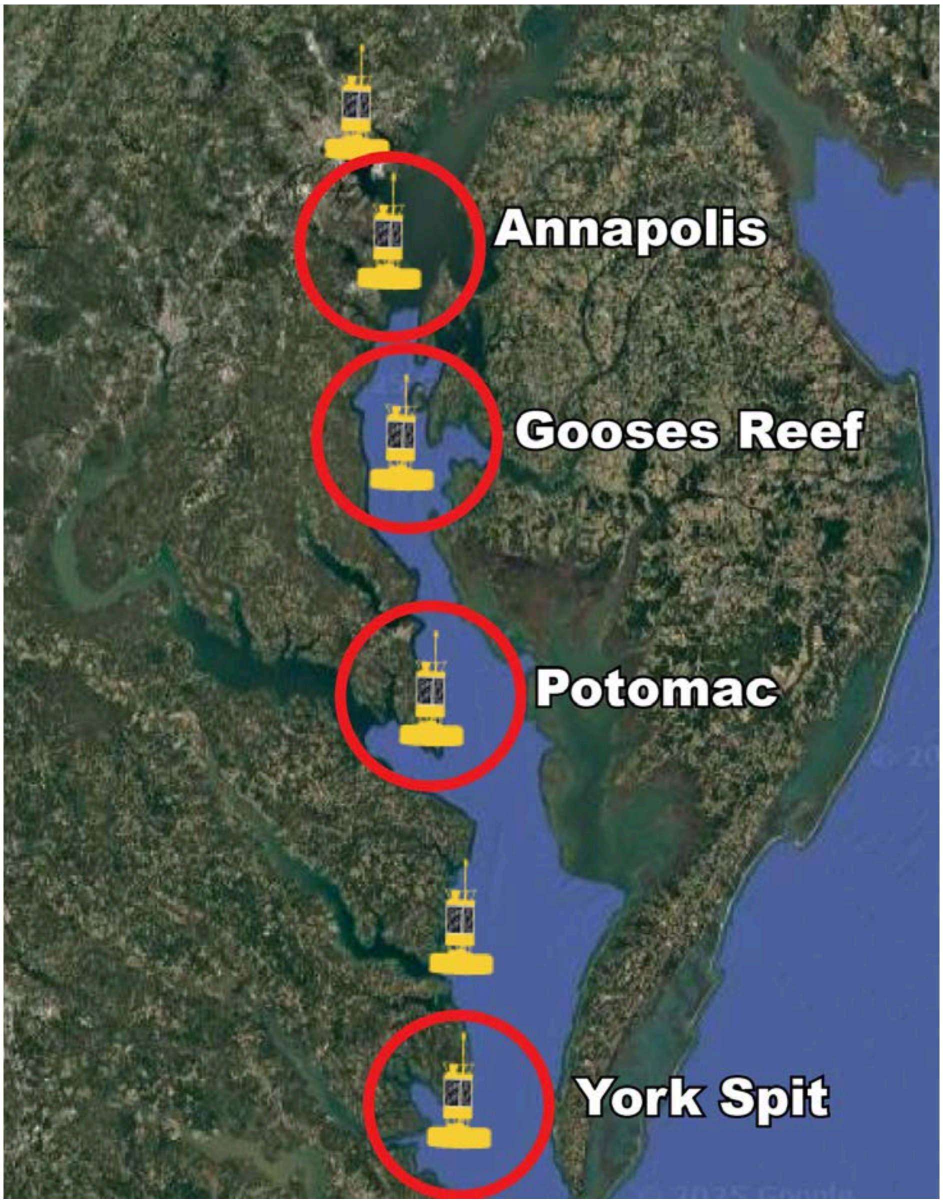

Figure 1. Map of Chesapeake Bay Interpretive Buoy System (CBIBS) observation platforms. The buoys used in these summaries are Annapolis, Gooses Reef, Potomac, and York Spit.

Water Temperature

Coastal sea-surface temperatures (SST), as observed by NOAA satellites, deviated both above and below average. Anomalies in the Bay were greatest in the southern and southeastern regions (where water temperatures were slightly warmer) and in the northern Bay (where temperatures were slightly cooler) (Figure 2). However, the SST anomalies were within about 1°C of average in most places. This contrasts with spring 2024, where temperatures Bay-wide were higher than average.

Observations from NOAA Chesapeake Bay Interpretive Buoy System (CBIBS) buoys show a similar and expected pattern of increasing water temperatures from March through May. At the Annapolis, Gooses Reef, Potomac, and York Spit CBIBS stations, overall, water temperatures warmed through spring (Figures 3, 4, 5, and 6). Water temperatures at all stations were below average in March, several degrees above average from the beginning of May to mid May, and then again below average at the end of May.

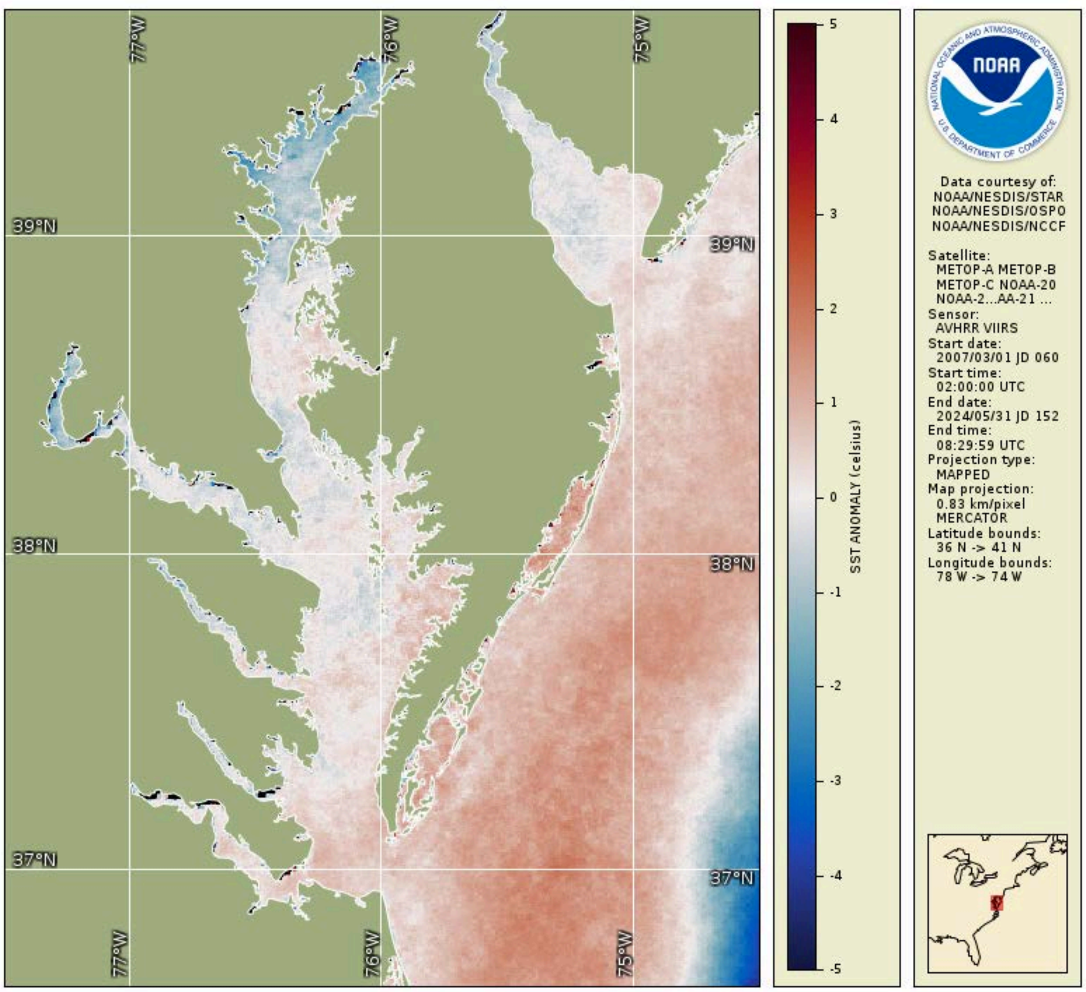

Figure 2. Sea surface temperature (SST) anomalies observed by NOAA satellites March–May 2025 relative to the average of this seasonal period 2007–2024.

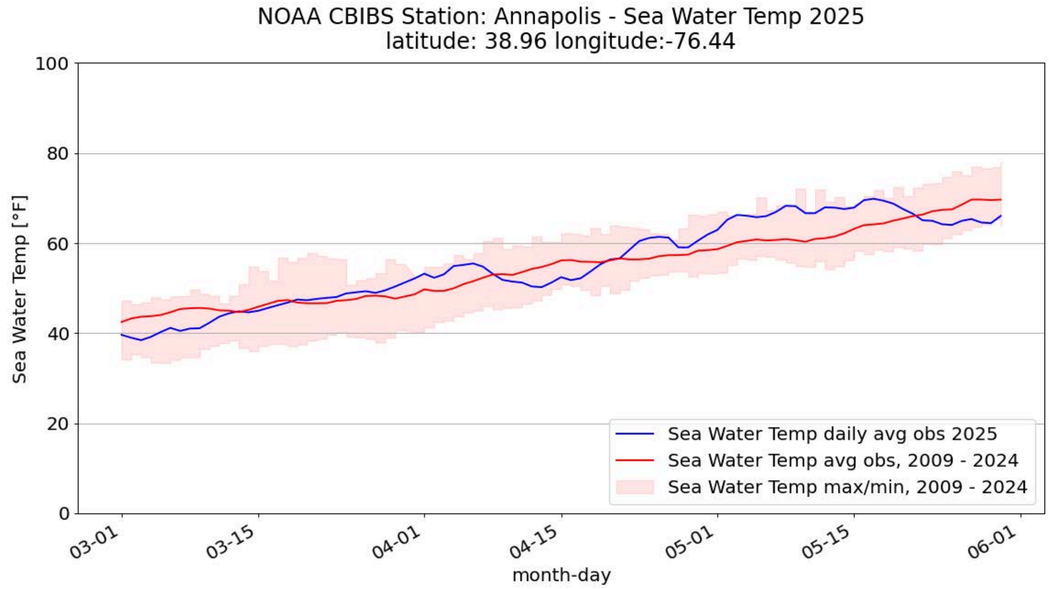

Figure 3. Surface water temperatures at the Annapolis CBIBS buoy March–May 2025 relative to the long-term average (2009–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.

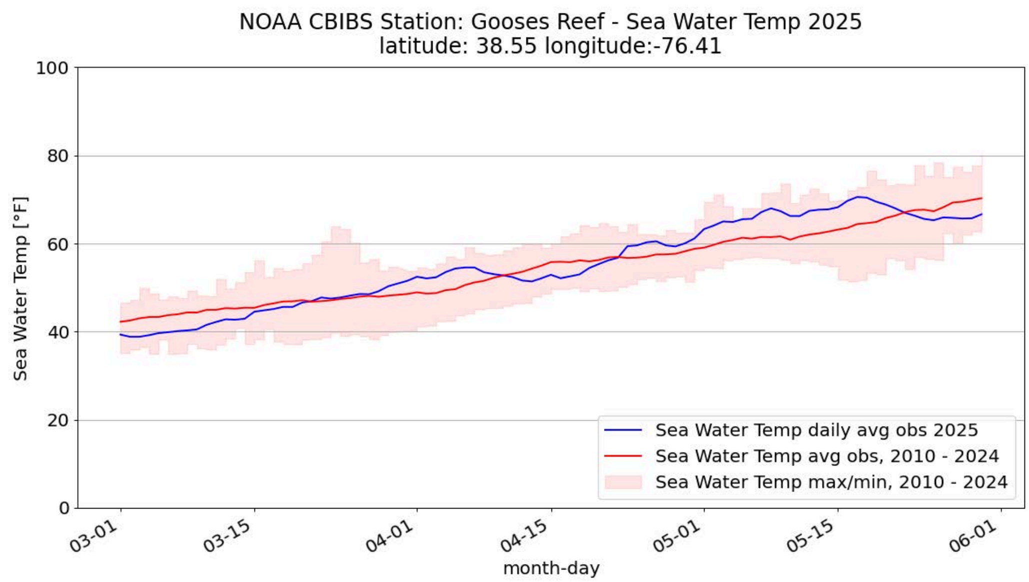

Figure 4. Surface water temperatures at the Gooses Reef CBIBS buoy March–May 2025 relative to the long-term average (2010–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.

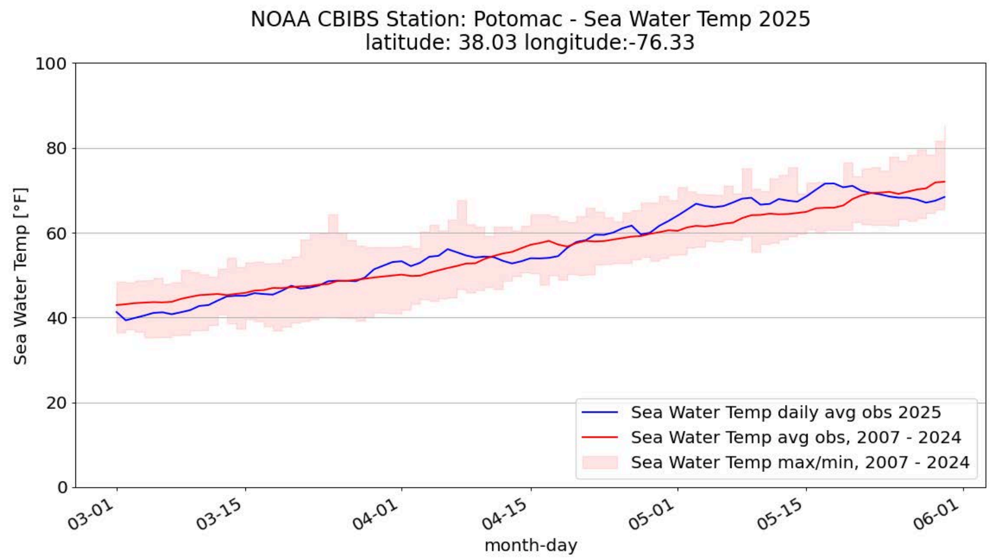

Figure 5. Surface water temperatures at the Potomac CBIBS buoy March–May 2025 relative to the long-term average (2007–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.

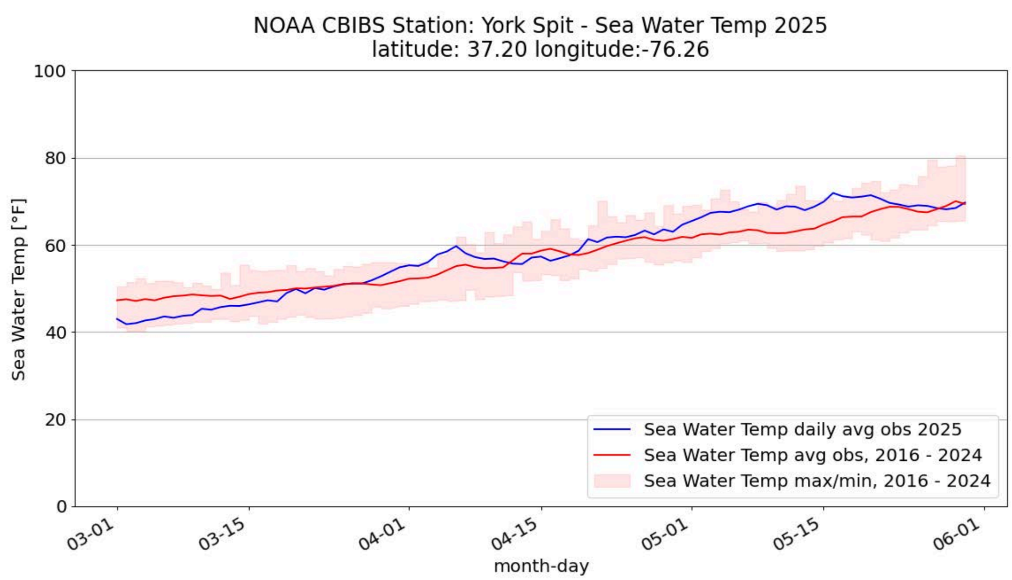

Figure 6. Surface water temperatures at the York Spit CBIBS buoy March–May 2025 relative to the long-term average (2007–2024). The shaded area represents the full range of observations (minimum to maximum) over the time period.

Salinity

Salinity was above average at the Annapolis, Gooses Reef, Potomac, and York Spit CBIBS buoys from most of March into May (Figures 7, 8, 9, and 10). This continues the trend from [winter 2025](), when salinity was above average at all buoy stations. It is in contrast to [spring 2024](), when salinity was below average. The Annapolis CBIBS buoy showed a large drop in salinity in early March; salinity then rose and fell at that location through May (Figure 7) while staying above the long-term average. Salinity at Annapolis and Gooses Reef was about average from mid to late May (Figures 7 and 8).

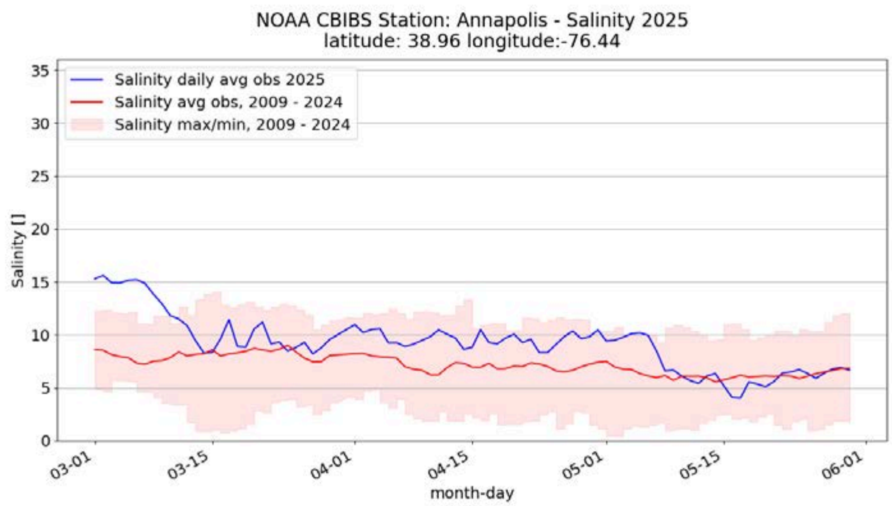

Figure 7. Salinity observations at the Annapolis CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2009–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

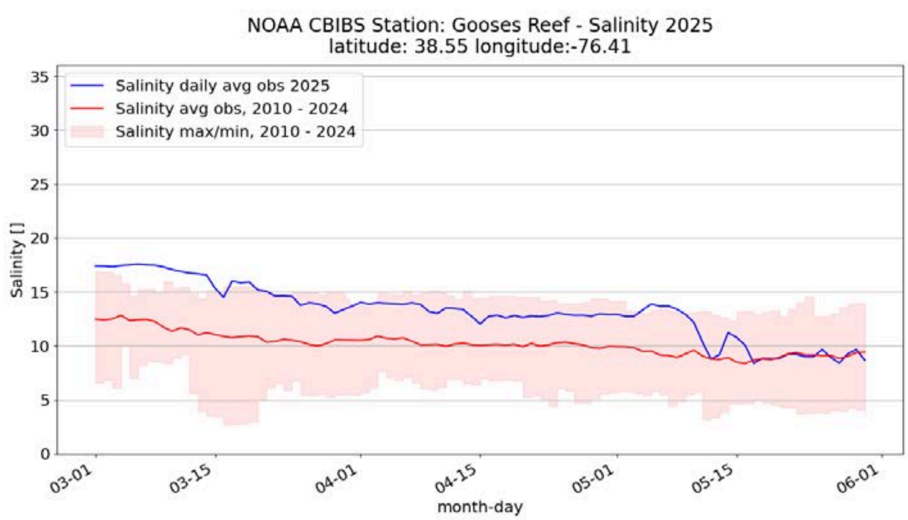

Figure 8. Salinity observations at the Gooses Reef CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2010–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

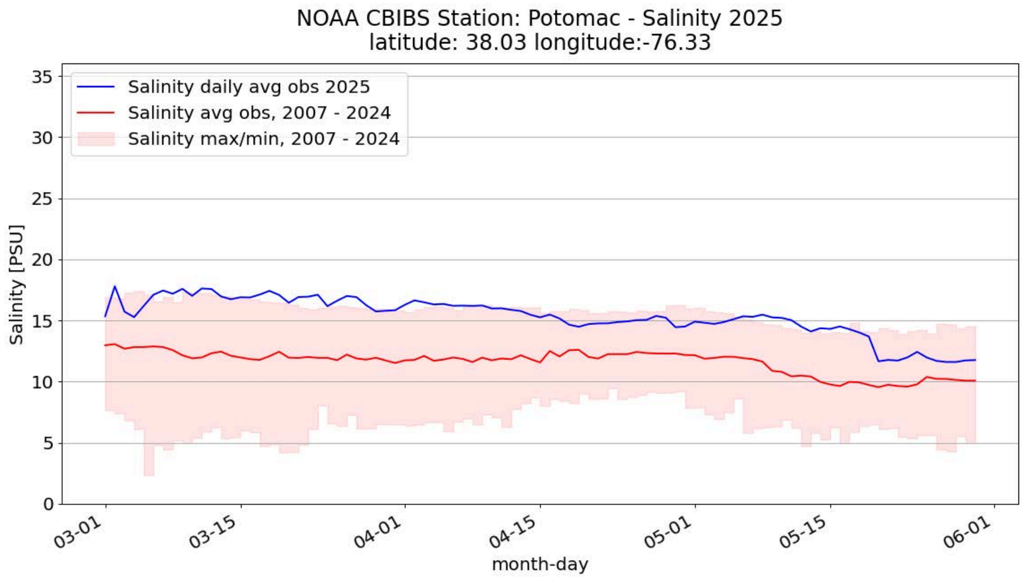

Figure 9. Salinity observations at the Potomac CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2007–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

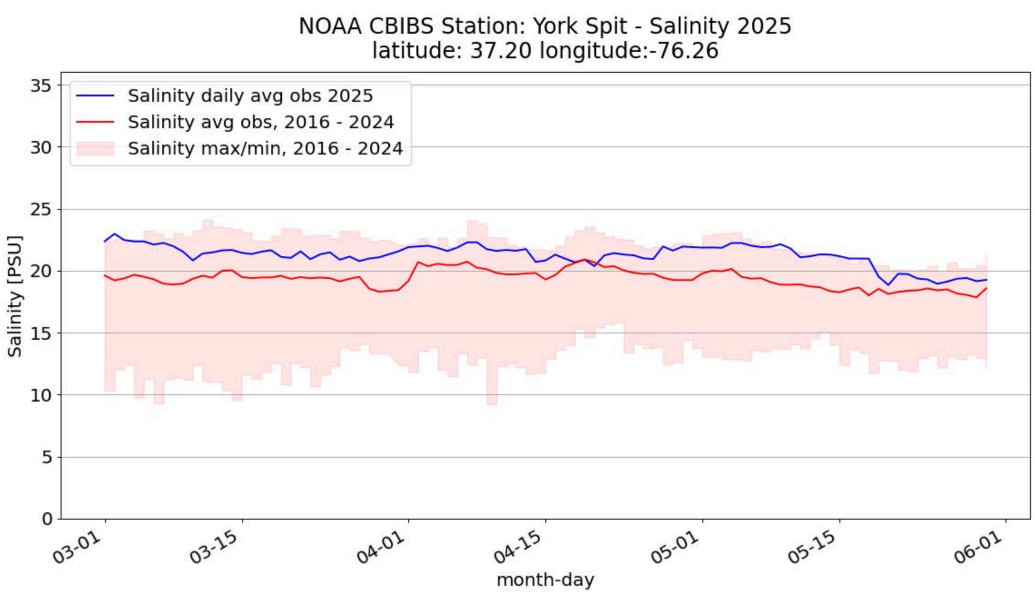

Figure 10. Salinity observations at the York Spit CBIBS buoy March–May 2025 (blue line) relative to the average at each buoy over this seasonal period 2007–2024 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

Precipitation and Freshwater Flow

According to precipitation data from NOAA's National Centers for Environmental Information, rainfall amounts for tidewater Virginia and southern Maryland were the third and fourth highest, respectively, since 2007 (Figures 11 and 12). Higher precipitation results in higher freshwater flow to the Bay. Pulses of flow above historic flow were observed at Choptank, Pamunkey, and Zekiah Swamp (Figure 13). Higher precipitation resulted in declines in salinity toward the end of spring, as observed by the Annapolis and Gooses Reef CBIBS buoys (Figures 7 and 8). While precipitation was relatively high for spring compared to the 2007–2025 mean, it is important to note the region has experienced drier conditions since fall 2024. Some areas continued to be in moderate drought conditions at the end of spring.

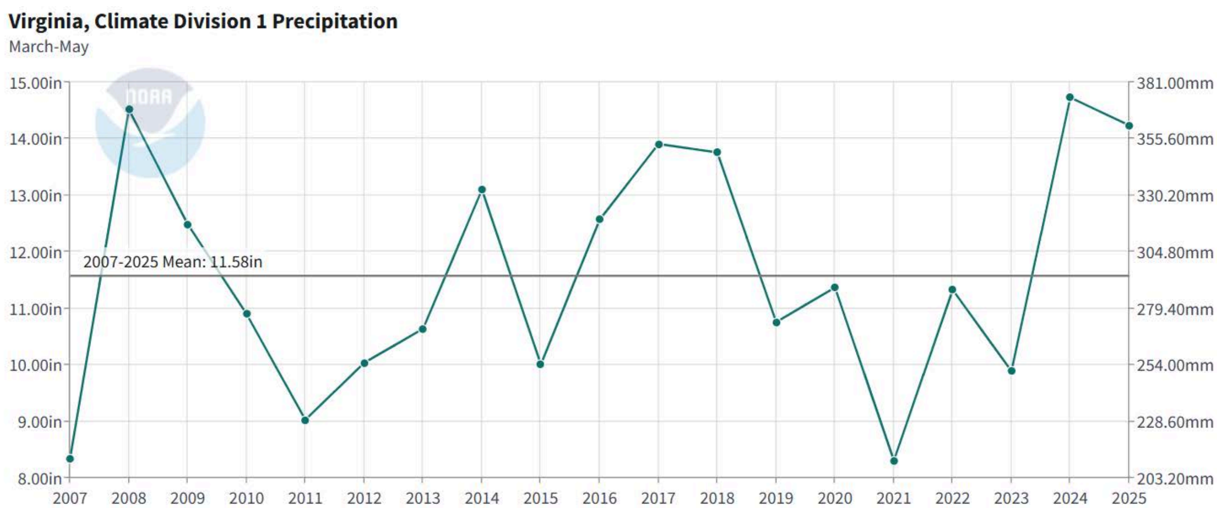

Figure 11. Precipitation data from 2007–2025 for March–May for Tidewater Virginia. Data from NOAA Centers for Environmental Information.

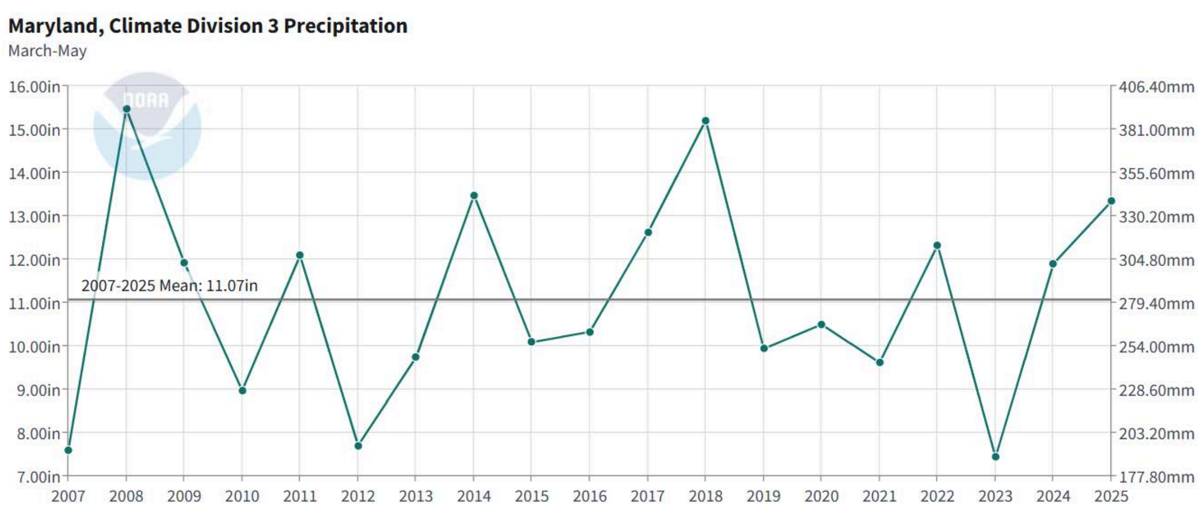

Figure 12. Precipitation data from 2007–2025 for March–May for southern Maryland. Data from NOAA Centers for Environmental Information.

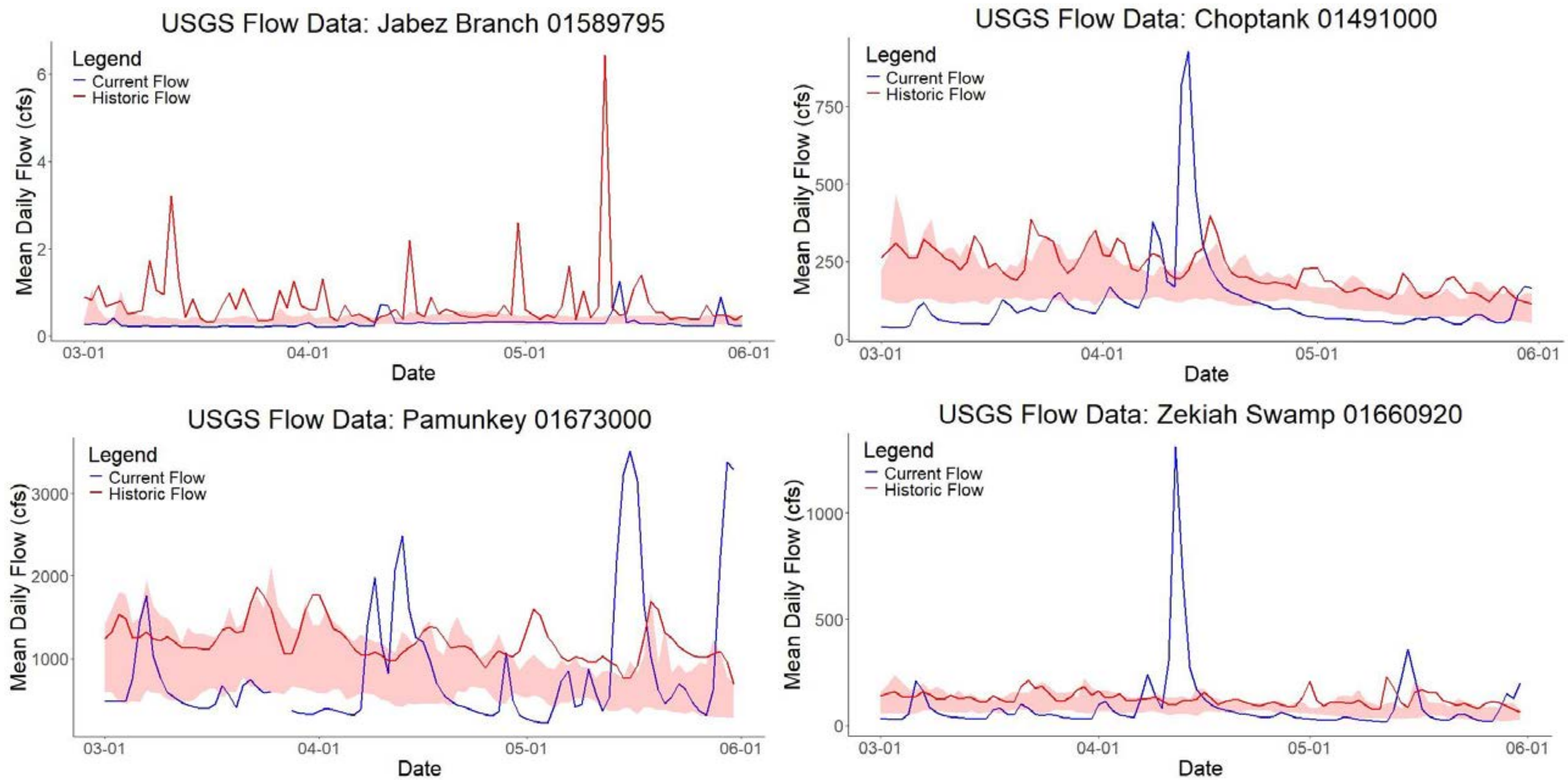

Figure 13. Daily mean streamflow observations (discharge, cubic feet/second) from the upper to lower Chesapeake Bay at U.S. Geological Survey monitoring sites at the (A) Jabez Branch, Severn River (B) Choptank River, (C) Pamunkey River, and (D) Zekiah Swamp, Potomac River throughout spring 2025 relative to the daily averages over this seasonal period from 2000–2024. The red shading indicates the interquartile range (25%-75%), where 50% of the historical values fall. These locations were chosen because they are fairly near the CBIBS Annapolis, Gooses Reef, York Spit, and Potomac locations respectively.

Dissolved Oxygen

Dissolved oxygen (DO) levels as tracked at NCBO's Lower Choptank and Sharps Island hypoxia monitoring buoys remained mostly within the historical range of values, with Lower Choptank remaining well above the biological threshold of 4 mg/L. Sharps Island daily averages hovered above or around the historical mean.

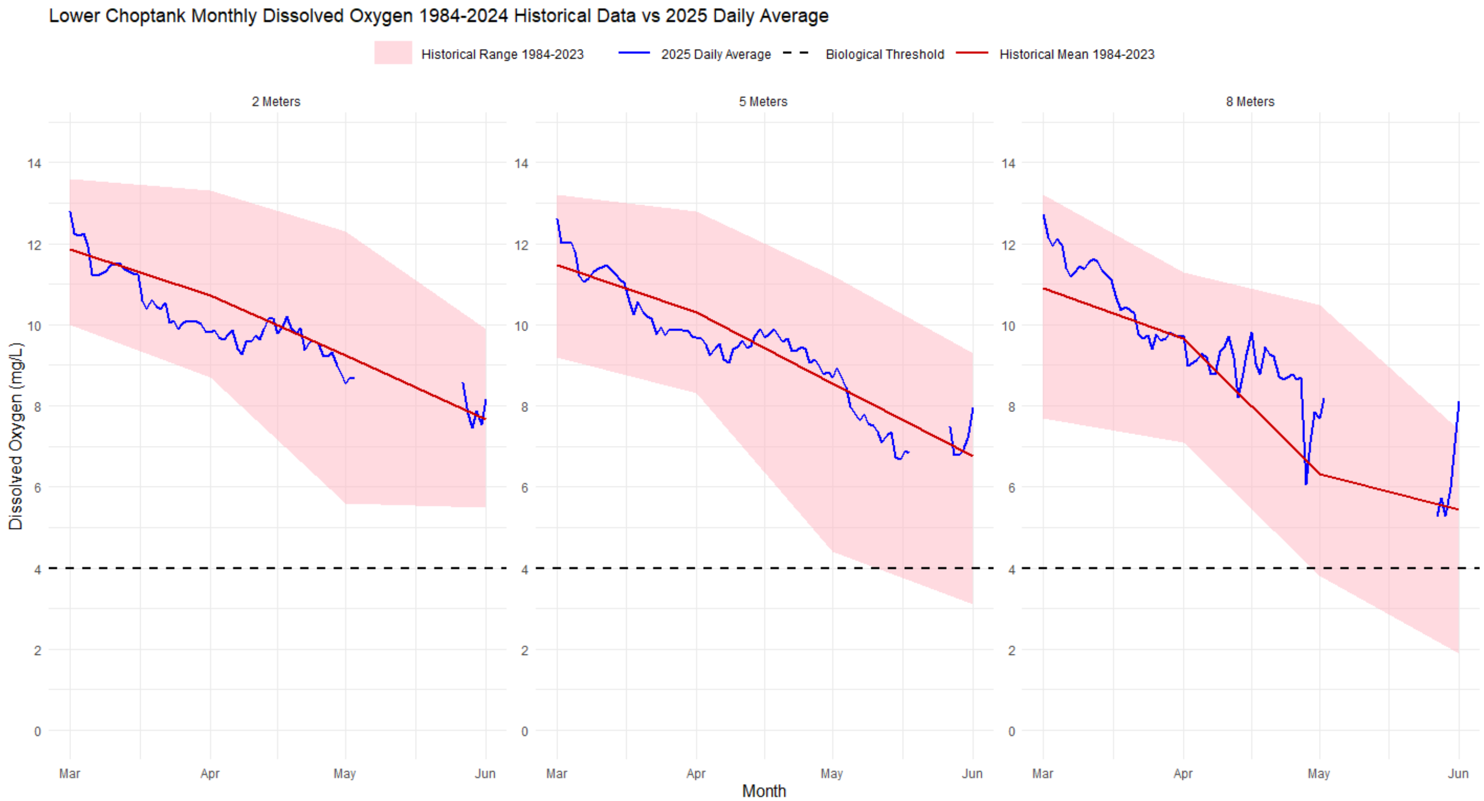

Figure 14. Dissolved oxygen (DO) daily averages at the Lower Choptank buoy for March–May 2025 compared with long-term averages (1984-2024) from the DNR EE2.1 fixed monthly monitoring station. The plots are separated by sensor depth, with the 8-meter plot using historical data from a 7-meter depth due to the absence of 8-meter historical data. The shaded area represents the historical range (minimum to maximum) of DO observations from the EE2.1 station, while the red line represents the historical mean. The 2025 daily average DO is shown by the blue line, and the black dashed line represents the biological threshold, marking the point at which aquatic life may alter its behavior to avoid low DO areas. Gaps in dissolved oxygen data are the result of station outages, sensor outages, or sensor data that does not meet QA/QC standards.

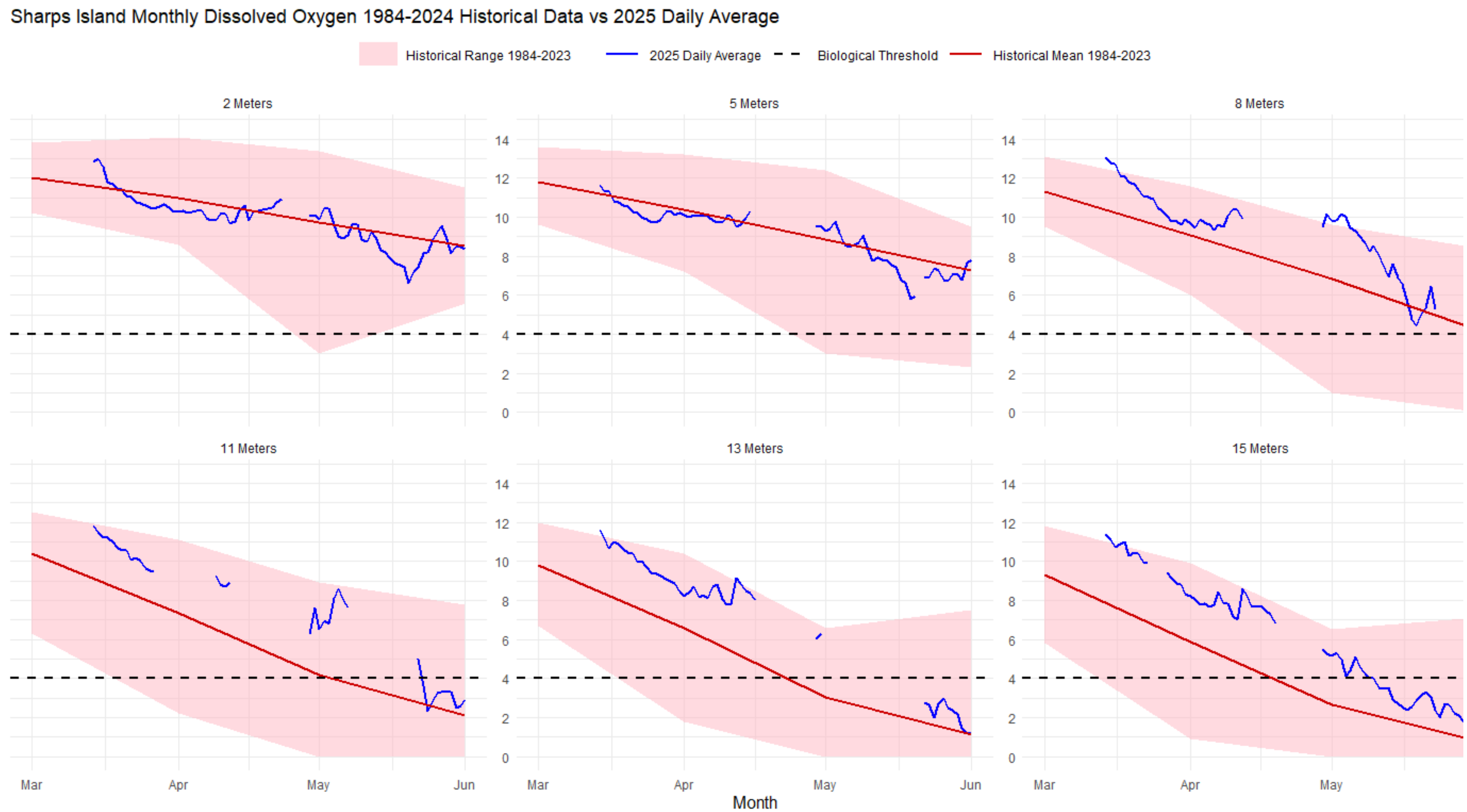

Figure 15. Dissolved oxygen (DO) daily averages at the Sharps Island buoy for March–May 2025 compared with long-term averages (1984-2024) from the DNR CB4.2C fixed monthly monitoring station. The shaded area represents the historical range (minimum to maximum) of DO observations from the CB4.2C station, while the red line represents the historical mean. The 2025 daily average DO is shown by the blue line, and the black dashed line represents the biological threshold, marking the point at which aquatic life may alter its behavior to avoid low DO areas. Gaps in dissolved oxygen data are the result of station outages, sensor outages, or sensor data that does not meet QA/QC standards.

Potential Effects of Anomalous Spring Conditions on Living Resources

Striped Bass

Temperature affects the timing of striped bass spawning activity, and recruitment success appears to be related to freshwater inflow (Martino & Houde 2010). Striped bass typically begin spawning in the spring when water temperatures reach 60°F, with most spawning occurring between 61°F and 69°F. This threshold was met at all buoy locations by about mid April (a month later than in spring 2024). The spawning season usually lasts from April to mid June.

Cold winter temperatures and high freshwater flow enhance striped bass recruitment by optimizing feeding opportunities. High freshwater flows promote the retention of larvae and zooplankton near the estuarine turbidity maximum, increasing coincidence of larvae and zooplankton (Martino & Houde, 2010). Cold winter temperatures help slow copepod development, which in turn creates peaks in spring copepod abundance (Millette et al., 2020).

Although winter 2025 experienced colder-than-average sea surface temperatures (which would benefit striped bass recruitment), the sporadic and lower flow observed in winter 2025 and at the beginning of spring 2025 may diminish striped bass spawning and recruitment success by altering the spatial coincidence of striped bass larvae and their preferred zooplankton prey (Martino & Houde, 2010; Millette et al., 2020).

Blue Crab

Blue crabs emerge from overwintering burrows at 50°F. This threshold was met at all buoy locations in the later half of March. Spring's warmer water temperatures cue blue crabs to begin reproducing. The minimum temperature for reproductive activity (mating, ovarian development) is 53.6°F; 66.2°F is the minimum temperature for spawning (Schneider et al., 2024). Across all buoy locations, the minimum temperature for spawning was reached in the beginning of May. The pattern observed from the CBIBS buoys of increasing water temperatures from March through May may lead to spawning beginning earlier in the spring and thus a longer blue crab growing season (Schneider et al., 2024).

Oysters

Oyster spawning can be triggered at about 60°F; this threshold was met at all buoy locations by about mid April (a month later than in spring 2024). Higher salinity is generally better for oyster reproduction and hatchery operations. As sessile organisms, oysters are particularly susceptible to hypoxia. Spring 2025's relatively low levels of hypoxia bode well for oyster survival.

Blue Catfish

Blue catfish are limited to water with salinity below 14 PSU. Because of this, their movement may have been constrained to upstream in fresher-water areas of southern rivers like the York and Potomac, as CBIBS salinity observations at the mouths of those rivers there remained above 14 all spring. For more northern tributaries like the Severn River, salinity dropped from more than 15 PSU in early spring, enabling blue catfish to move more freely.

References

Martino, E.J., and Houde, E.D. 2010. Recruitment of striped bass in Chesapeake Bay: spatial and temporal environmental variability and availability of zooplankton prey. Marine Ecology Progress Series, 409: 213–228.

Millette, N.C., Pierson, J.J., and North, E.W. 2020. Water temperature during winter may control striped bass recruitment during spring by affecting the development time of copepod nauplii. ICES Journal of Marine Science, 77: 300–314.

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Schneider A.K., Fabrizio M.C., and Lipcius R.N. 2024. Reproductive phenology of the Chesapeake Bay blue crab population in a changing climate. Front. Ecol. Evol., 11:1304021. doi: 10.3389/fevo.2023.1304021.