Synthesis of Environmental Conditions and Potential Effects on Key Fishery Resources in the Chesapeake Bay
Winter 2024–25 Seasonal Summary

Winter 2024–25 Headlines

- **Water temperatures were colder than average. Salinity was higher than average, corresponding with low precipitation and flow.**
- **Colder winters are generally better for striped bass, because they lead to better food availability in the spring. However, low precipitation and resulting low freshwater flow can diminish availability of important prey for larval striped bass.**
- **Lower winter temperatures can result in higher mortality for blue crabs and intertidal oysters.**

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

	Spring 2024	Summer 2024	Fall 2024	Winter 2024–25
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 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.

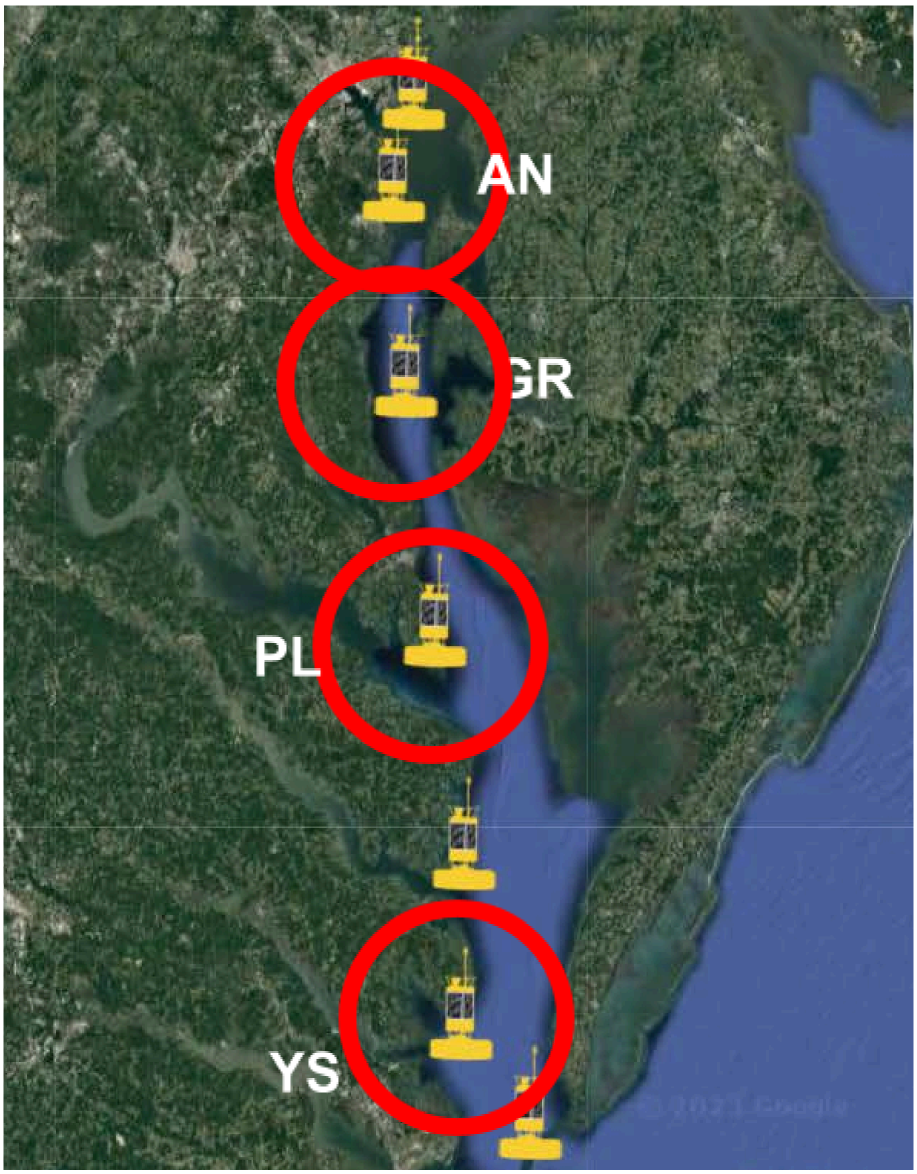

Figure 1. Map of Chesapeake Bay Interpretive Buoy System (CBIBS) observation platforms. The buoys used in these summaries are AN (Annapolis), GR (Gooses Reef), PL (Potomac), and YS (York Spit).

Water Temperature

The surface water temperature anomalies observed by NOAA satellites show generally cooler water temperatures throughout the Chesapeake Bay, with the exception of normal to slightly higher-than-average water temperatures in the northern bay around Susquehanna Flats (Figure 2). Data from CBIBS buoys show water temperature declining from December through late January before beginning to rise again in early February. Water temperatures at Annapolis, Gooses Reef, and York Spit CBIBS buoys were generally below the long-term average, at times by several degrees, during the winter months (Figures 3, 4, and 5). These observations contrast with [last winter](), where water temperatures were above average throughout the Bay.

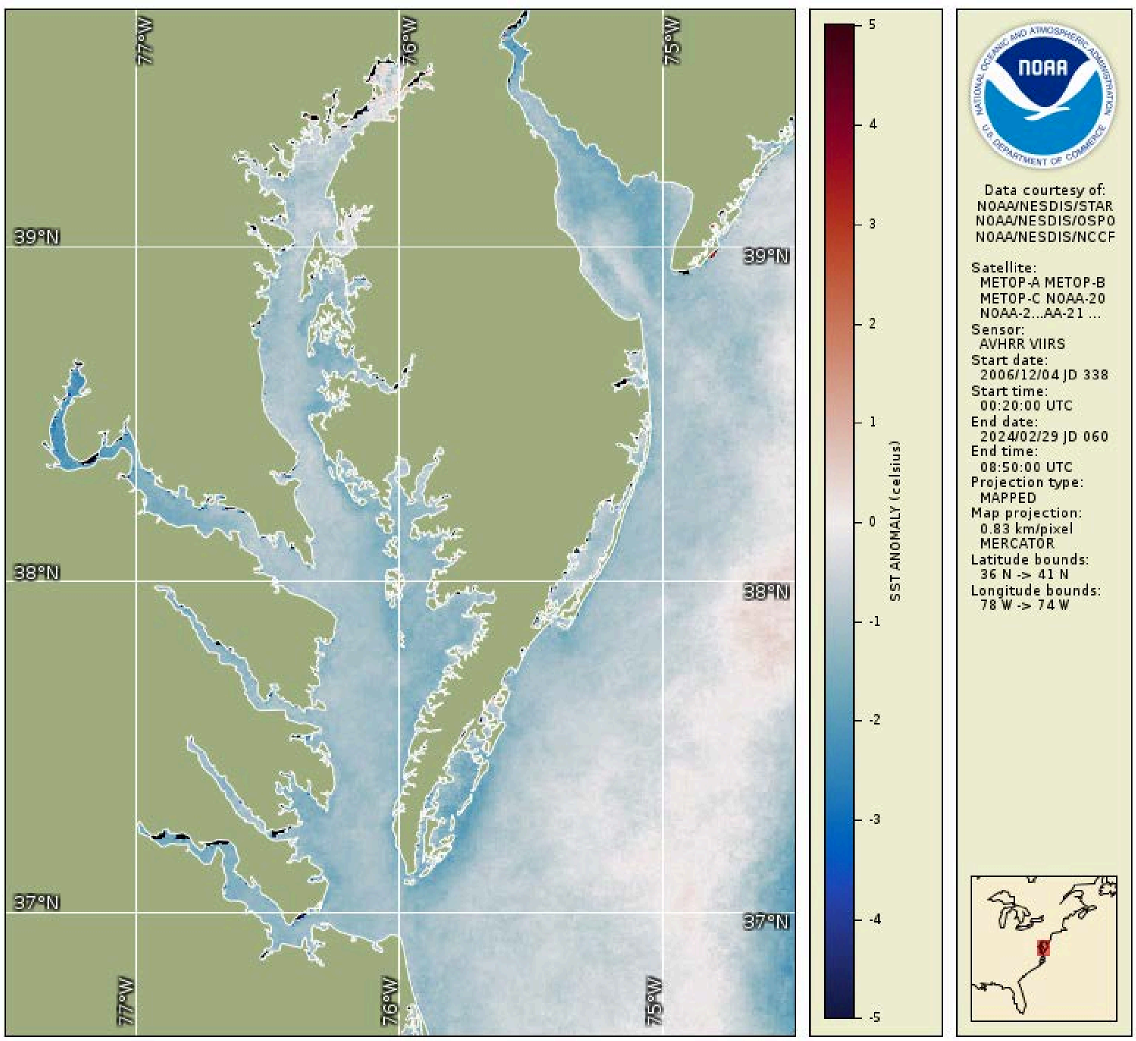

Figure 2. Sea surface temperature (SST) anomalies observed by NOAA satellites December 2024–February 2025 relative to the average of this seasonal period 2007–2023.

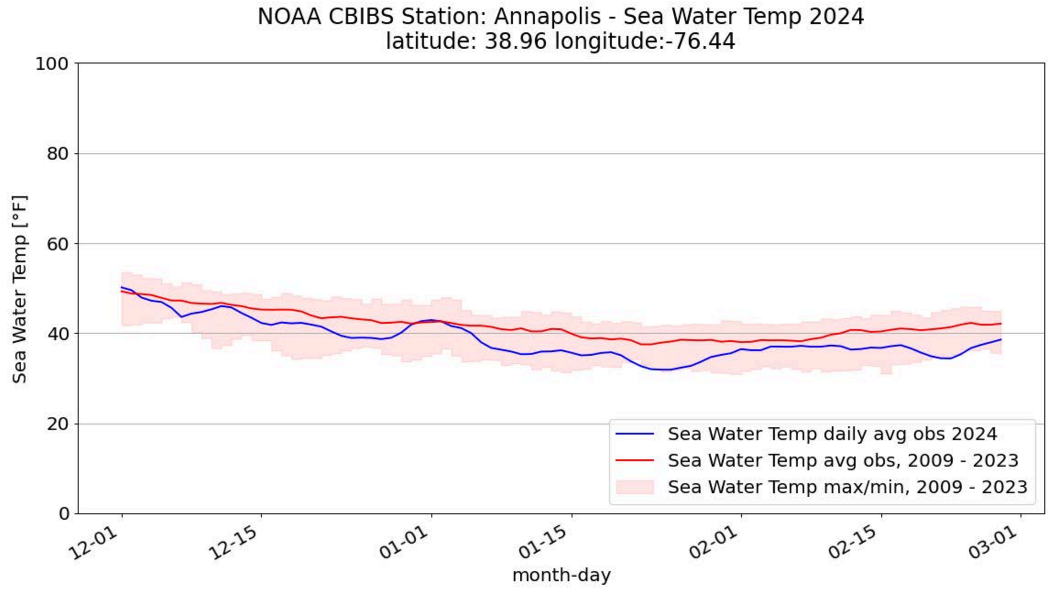

Figure 3. Surface water temperatures at the Annapolis CBIBS buoy December 2024–February 2025 relative to the long-term average (2009–2023). The shaded area represents the full range of observations (minimum to maximum) over the time period.

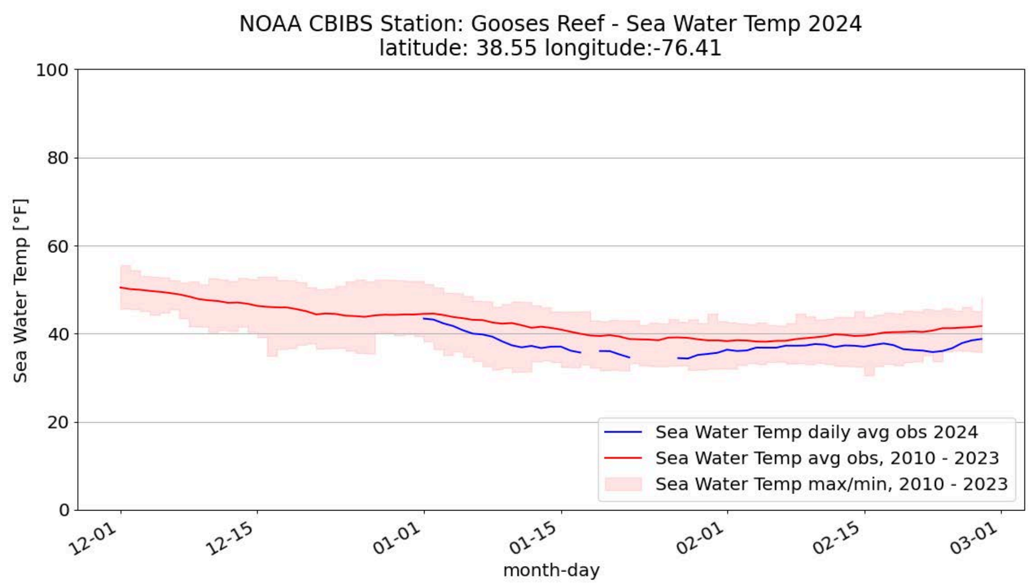

Figure 4. Surface water temperatures at the Gooses Reef CBIBS buoy December 2024–February 2025 relative to the long-term average (2010–2023). The shaded area represents the full range of observations (minimum to maximum) over the time period. Gaps in data, notably in December, are due to equipment failure.

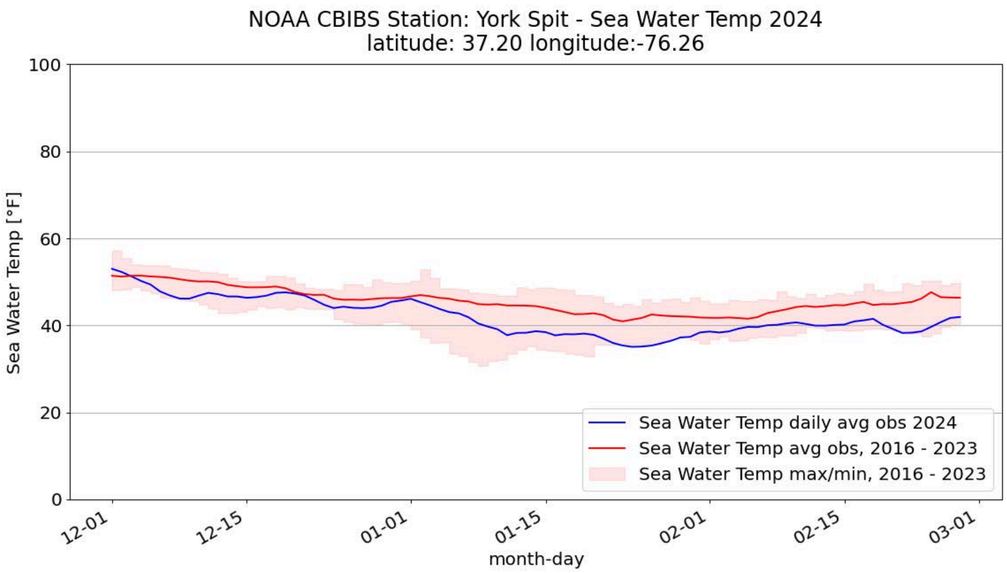

Figure 5. Surface water temperatures at the York Spit CBIBS buoy December 2024–February 2025 relative to the long-term average (2007–2023). The shaded area represents the full range of observations (minimum to maximum) over the time period.

Note: Our analysis usually includes data from the CBIBS Potomac location, but data were not reliably available from this buoy for the bulk of December 2024–February 2025.

Salinity

Data on salinity from CBIBS buoys show generally higher-than-average salinity relative to the long-term average at all stations for the winter months (Figures 6, 7, and 8). The most extreme differences in salinity from the long-term average were observed at the Annapolis CBIBS buoy, where salinity was higher in early December, dropped to near average from mid December to early January, then increased to several PSUs above average through March 1 (Figure 6). Salinity was well above average at Gooses Reef from early January through March 1 (Figure 7). The York Spit buoy data show salinity was close to average December through early January, then was a few PSUs above average from January until after mid February (Figure 8). This contrasts with last winter, where salinity was generally lower than average.

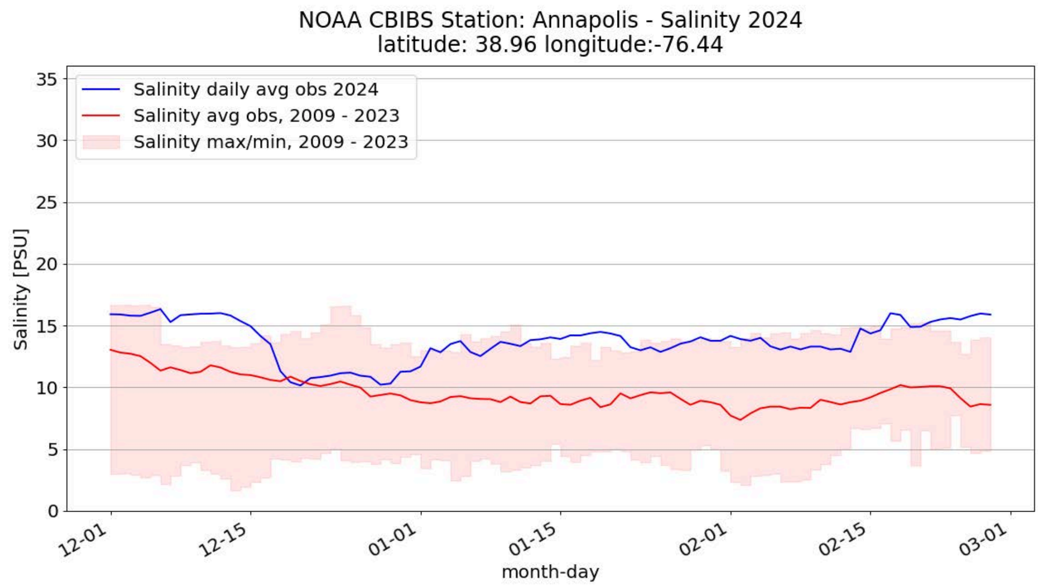

Figure 6. Salinity observations at the Annapolis CBIBS buoy December 2024–February 2025 (blue line) relative to the average at each buoy over this seasonal period 2009–2023 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

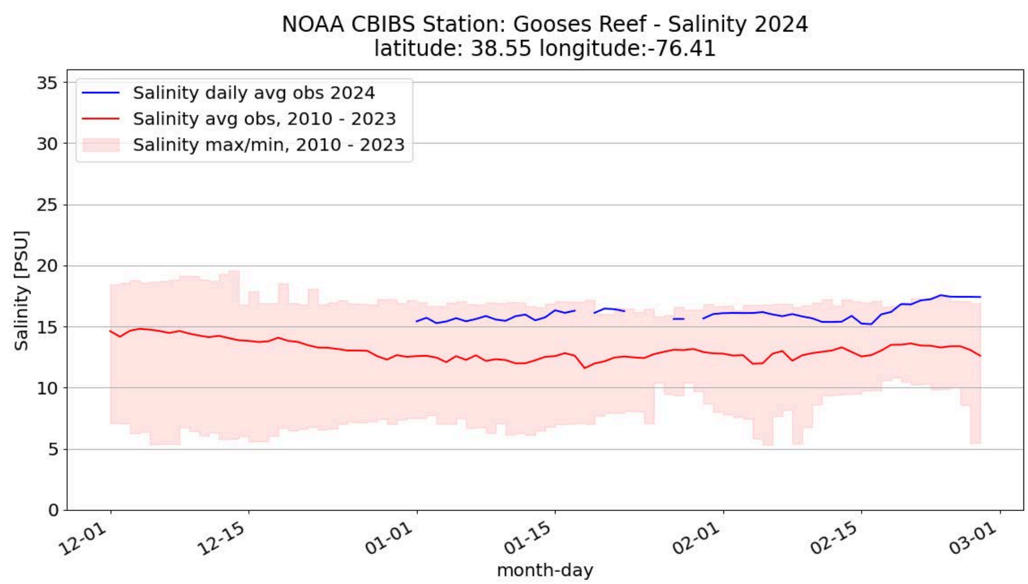

Figure 7. Salinity observations at the Gooses Reef CBIBS buoy December 2024–February 2025 (blue line) relative to the average at each buoy over this seasonal period 2010–2023 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period. Gaps in data, notably in December, are due to equipment failure.

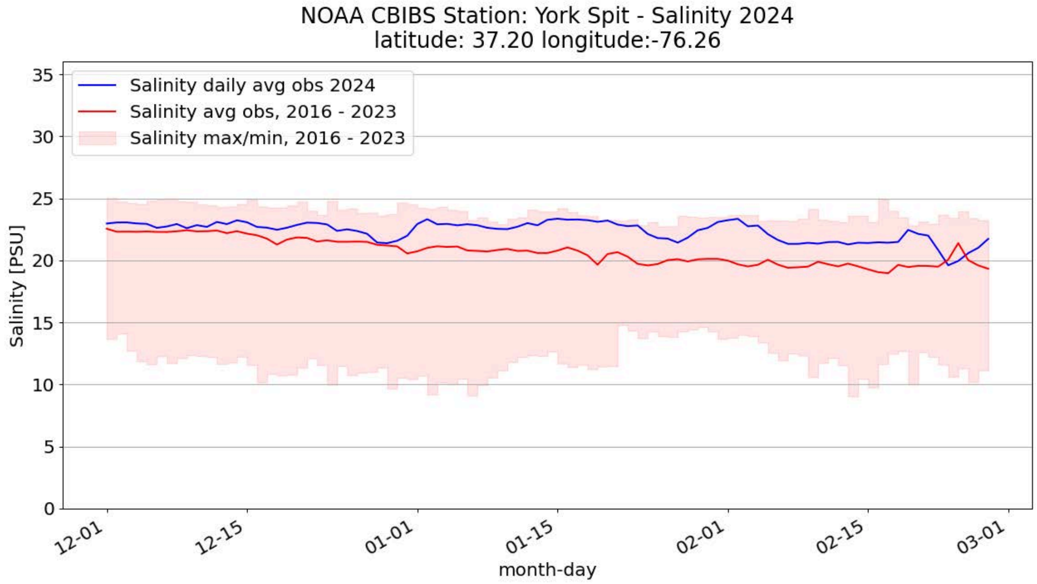

Figure 8. Salinity observations at the York Spit CBIBS buoy December 2024–February 2025 (blue line) relative to the average at each buoy over this seasonal period 2007–2023 (red line). The shaded area represents the full range of observations (minimum to maximum) over the time period.

Note: Our analysis usually includes data from the CBIBS Potomac location, but data were not reliably available from this buoy for the bulk of December 2024–February 2025.

Precipitation and Freshwater Flow

The December–February data from the NOAA Centers for Environmental Information for Tidewater Virginia show just-below-average precipitation compared to the 2007–2024 mean. Data for southern Maryland show the fifth-lowest precipitation total since 2007 for this time period.

USGS streamflow data show lower flow from December through February at Jabez Branch (Severn River, Maryland) and Choptank River compared to historic flow (Figure 11). Stream flow at Pamunkey River and Zekiah Swamp stations (off the Potomac River) show lower than historic streamflow from December through early February before streamflow spiked three times in February to historic and well above historic levels (Figure 11).

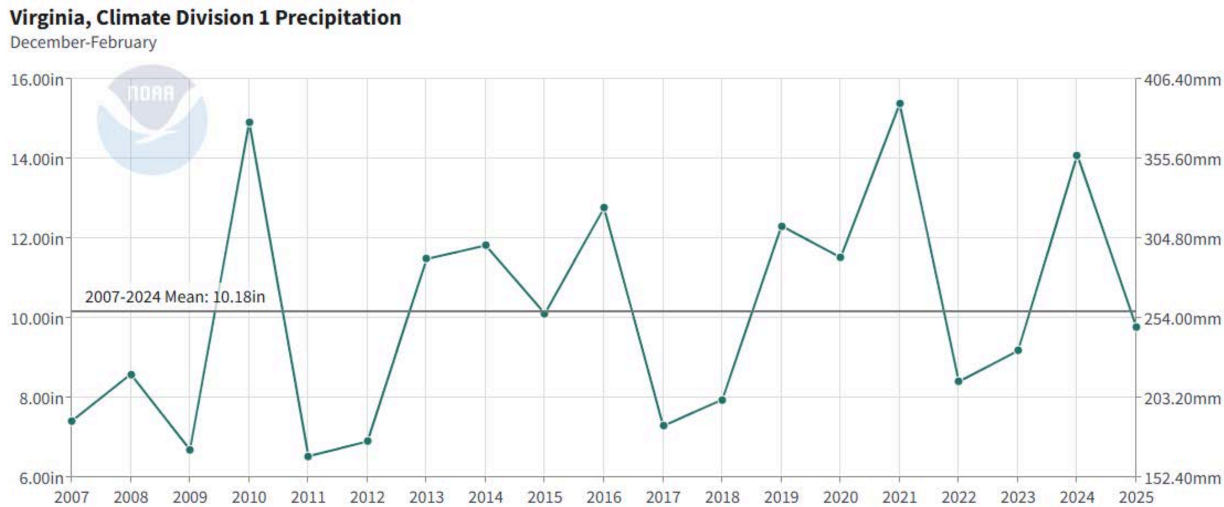

Figure 9. Precipitation data from 2007–2024 for December–March for Tidewater Virginia. Data from NOAA Centers for Environmental Information.

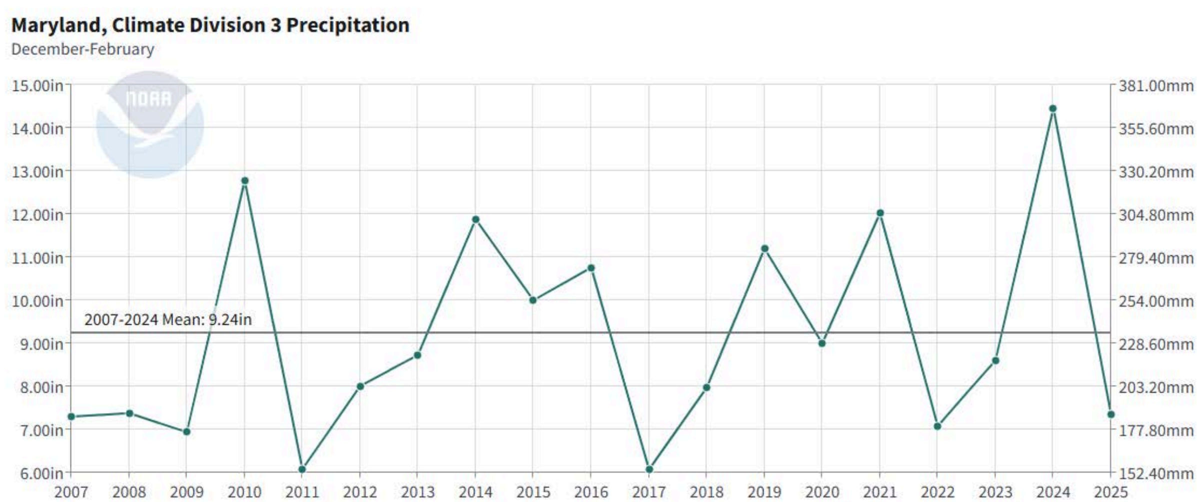

Figure 10. Precipitation data from 2007–2024 for December–March for southern Maryland. Data from NOAA Centers for Environmental Information.

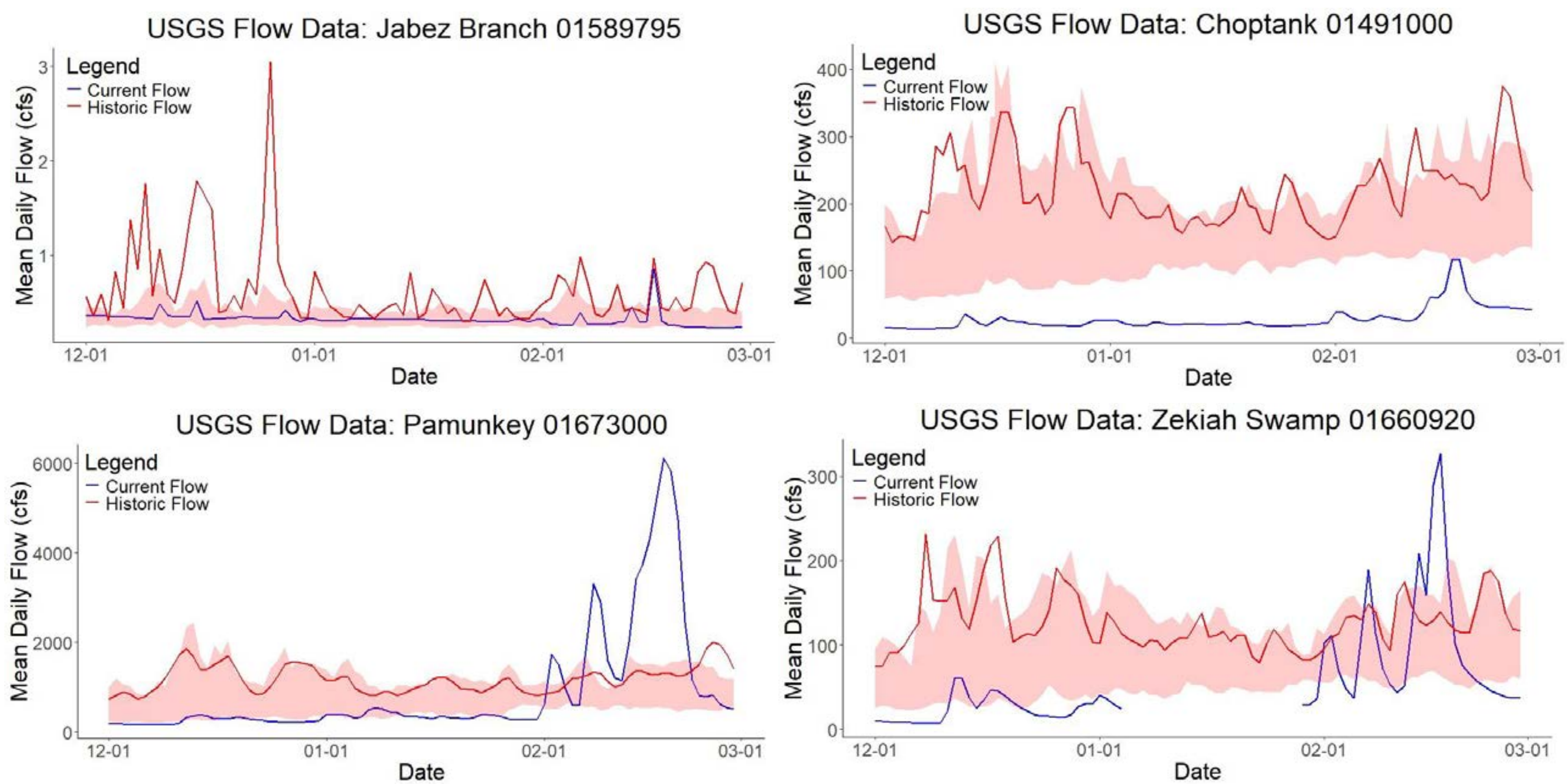

Figure 11. Daily mean streamflow observations (discharge, cubic feet/second) from the upper to lower Chesapeake Bay at U.S. Geological Survey monitoring sites at the (A) Jabez Branch, Severn River (B) Choptank River, (C) Pamunkey River, and (D) Zekiah Swamp, Potomac River throughout winter 2024–25 relative to the daily averages over this seasonal period from 2000–2023. 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

The Lower Choptank station was the only hypoxia monitoring station left in the water over the winter. Dissolved oxygen (DO) here generally remained below average at 2 and 5 meter depths from December through mid January before increasing to average and above average through February (Figure 15). There was more variability in DO at 8 meters, but overall, DO increased from December into February (Figure 15). DO levels were within the same range of about 10-13mg/L and remained well above the biological threshold at all depths.

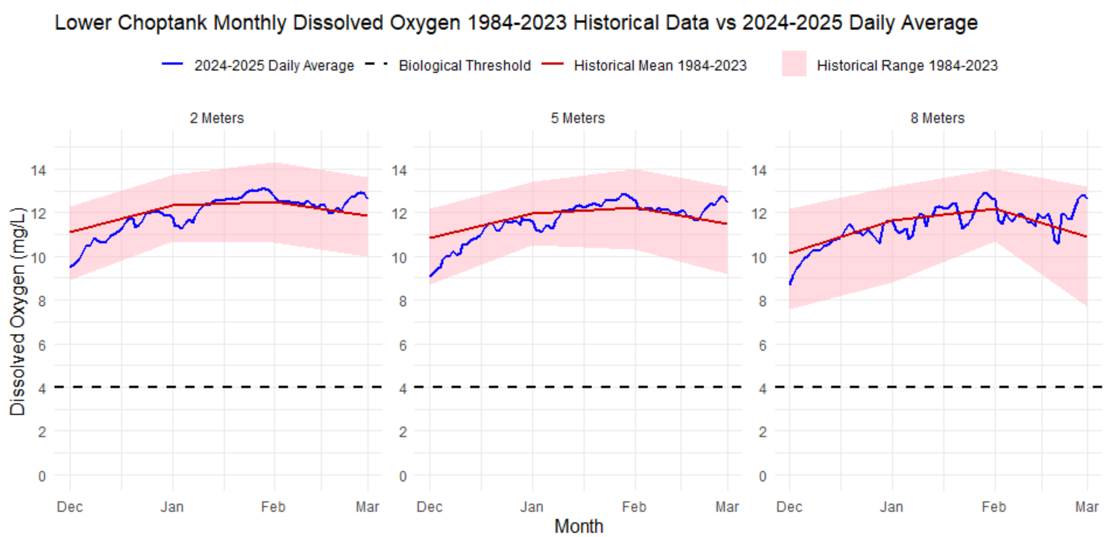

Figure 15. Dissolved oxygen (DO) daily averages at the Lower Choptank buoy for December 2024–February 2025 compared with long-term averages (1984-2023) from the DNR EE2.1 fixed monthly monitoring station. The plots are separated by sensor depth, with the 8-meter plot using historical data from a 7-meter 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 2024 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.

Potential Effects of Anomalous Winter Conditions on Living Resources

Striped Bass

Colder than average water temperatures this winter may be conducive for striped bass spawning this spring. Colder winters, particularly those with average temperatures below 41°F (5°C), can significantly enhance prey availability for striped bass by slowing the development of copepods (*Eurytemora carolleeae*), leading to larger peaks in prey abundance during spring when temperatures rise (Martino and Houde, 2010; Millette et al., 2020; Pierson et al., 2016).

However, higher than average salinity could offset the benefits of colder water temperatures. Higher salinity resulting from reduced freshwater discharge, often caused by lower precipitation, may counteract these benefits. Reduced freshwater flow diminishes the concentration of copepod prey available to striped bass larvae, making them more difficult to access (Martino and Houde, 2010; Millette et al., 2020). These contrasting conditions can create spatiotemporal mismatches between prey availability and striped bass larvae, where prey are present but not optimally located for feeding larvae (Martino & Houde, 2010). Such mismatches can lead to low recruitment despite favorable prey conditions during the season (Martino & Houde, 2010).

Blue Crab
Lab and field studies have estimated blue crab mortality thresholds relative to water temperature and salinity. Those thresholds as measured in the lab are 33.8F, with 8 PSU and in the environment below 38.12°F (mortality rate increase of 6.0–14.5%) (M.S. Rome et al., 2005). It is possible that the lower-than-average sea water temperatures this season (which dipped below the 38.12°F threshold) increased the overwintering mortality rate for blue crabs across the Chesapeake Bay. Blue crabs near the Annapolis station had the greatest possible risk of overwintering mortality due to the combination of low sea water temperature and lower salinity level experienced at this site.

Oysters
Colder winter water temperatures are typically the result of colder air temperatures. Intertidal oyster populations exposed at low tide to freezing air temperatures are likely to show high mortality levels. Subtidal oysters would be unaffected.

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.

M.S. Rome, A.C. Young-Williams, G.R. Davis, A.H. Hines. Linking temperature and salinity tolerance to winter mortality of Chesapeake Bay blue crabs (*Callinectes sapidus*), Journal of Experimental Marine Biology and Ecology, Volume 319, Issues 1–2, 2005, Pages 129-145, ISSN 0022-0981, https://doi.org/10.1016/j.jembe.2004.06.014.

Pierson, J. J., Kimmel, D. G., and Roman, M. R. 2016. Temperature impacts on Eurytemora carolleeae size and vital rates in the Upper Chesapeake Bay in winter. Estuaries and Coasts, 39: 1122–1132. doi: 10.1007/s12237-015-0063-z.