

# Evaluating Temperature and Dissolved Oxygen Impacts on Trout Streams in Virginia: TMDL Strategies for Conservation

## Overview

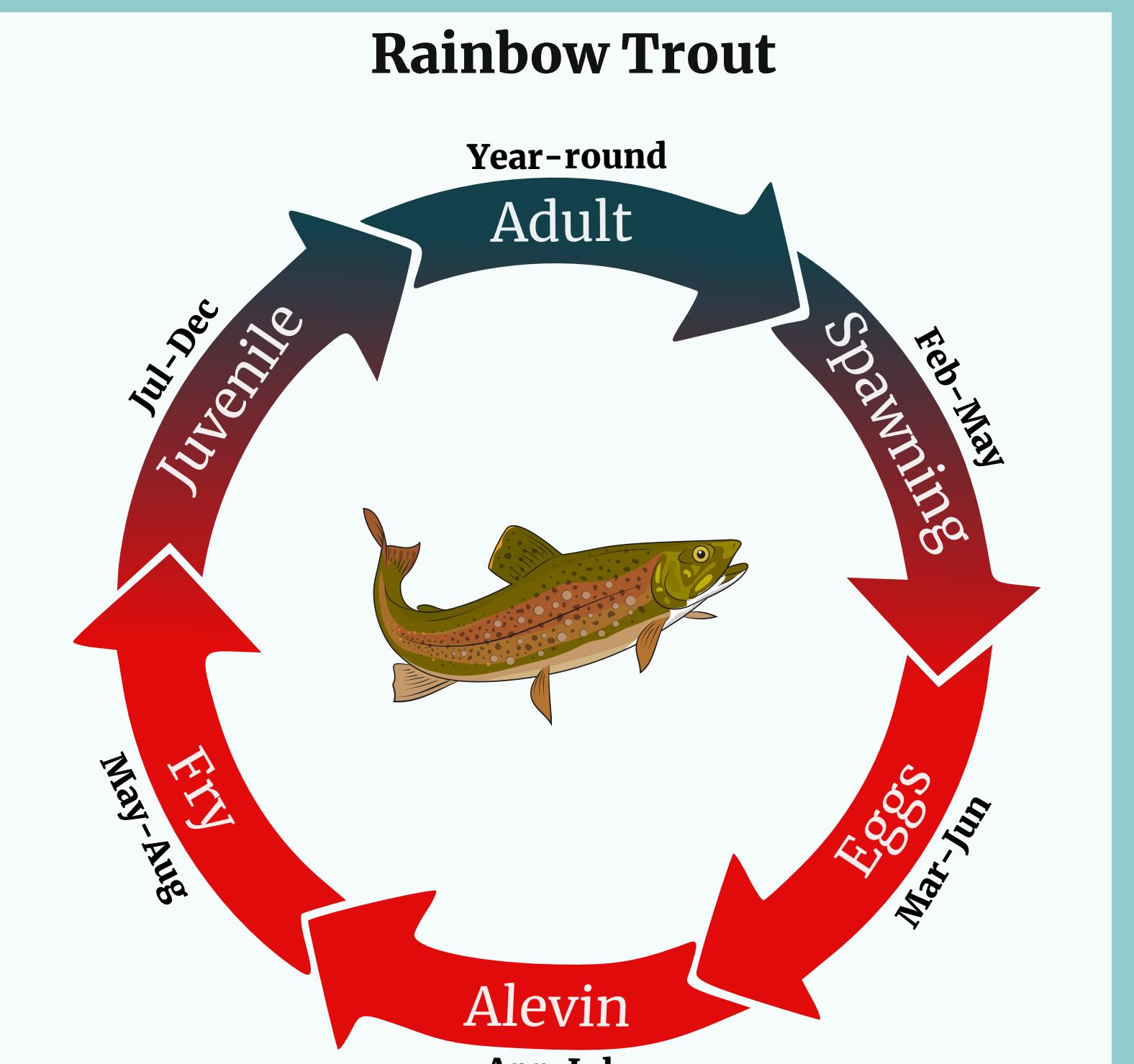
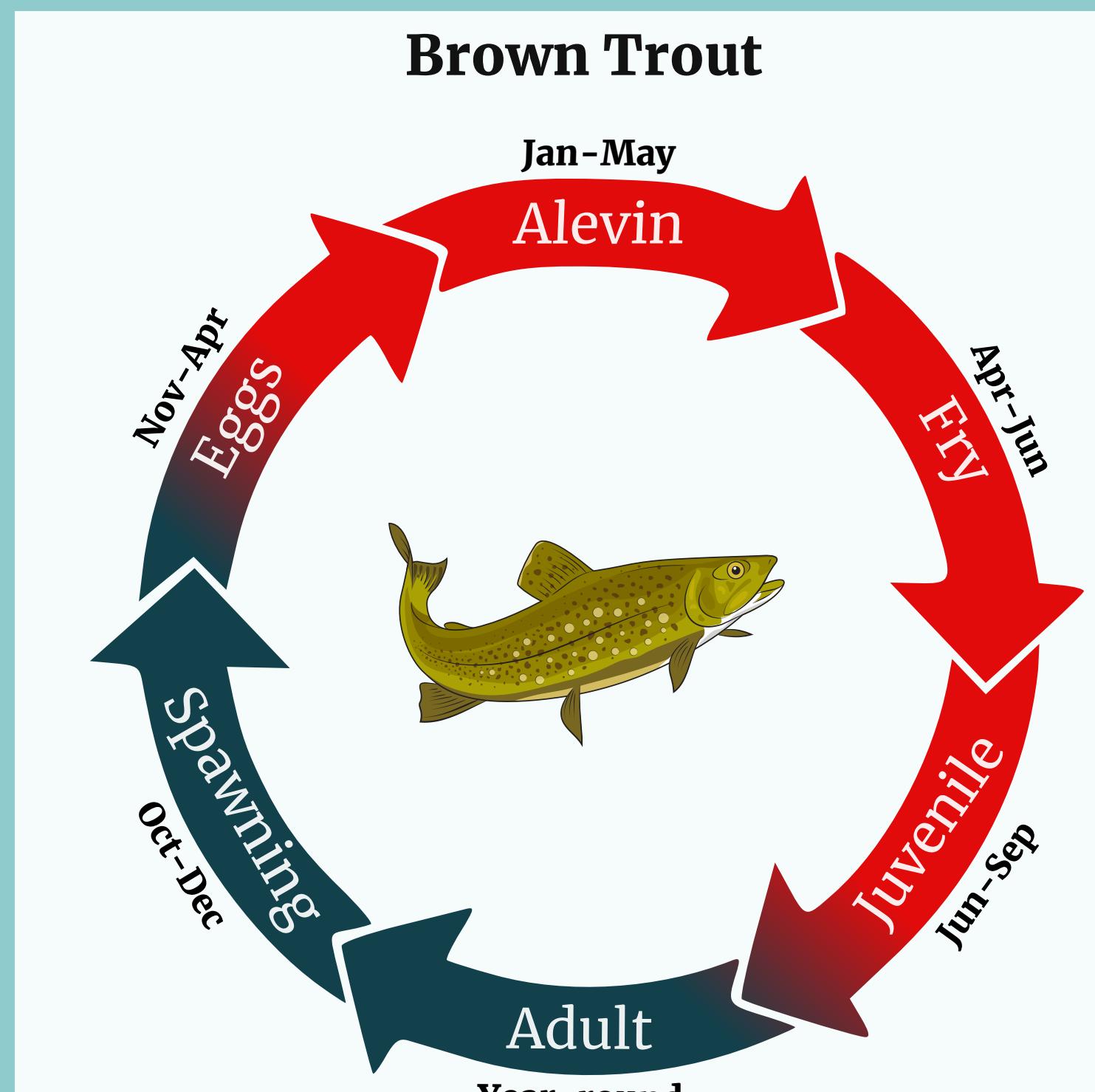
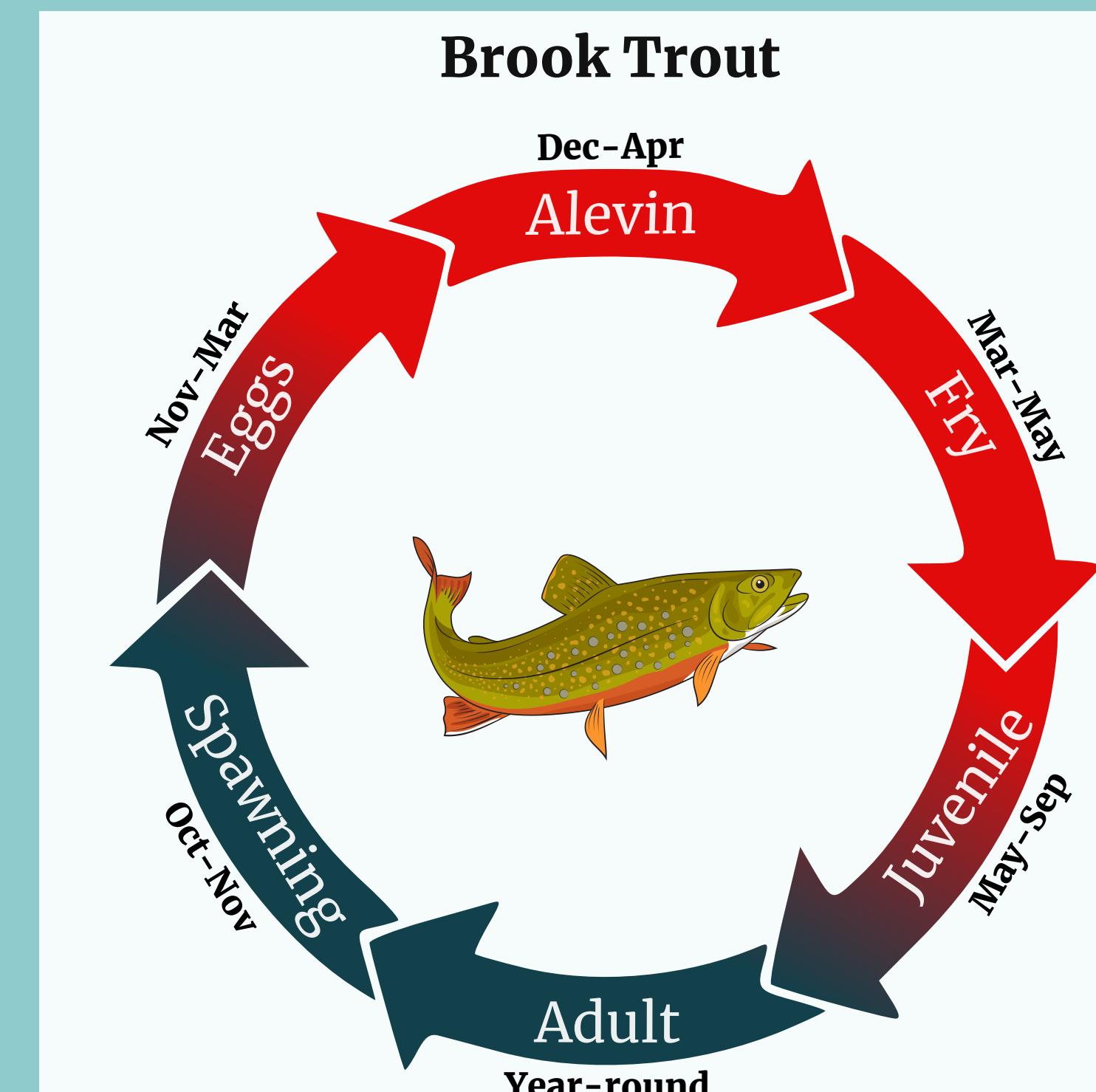
Trout are a cold-water fish species that play a significant role in Virginia's freshwater ecosystems, serving as both predators and prey within aquatic food webs. They are highly sensitive to environmental conditions, making them valuable bioindicators of stream health. Native brook trout (*Salvelinus fontinalis*), as well as introduced species like brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), require cold, well-oxygenated waters to survive. Temperature is a critical factor, as trout experience physiological stress when water temperatures exceed their optimal range, typically in the 50s and low 60s (°F), with sustained exposure to temperatures above 70°F being lethal. Developing eggs in streambed gravels are even more temperature-sensitive than adult trout, requiring clean, well-aerated gravel for successful development (Snyder et al., 2015; Kirk et al., 2022; Deitchman and Loheide, 2012).

Dissolved oxygen (DO) is another essential factor for trout survival, as they are active fish that require high oxygen levels—at least 6 milligrams per liter (mg/L) in most coldwater streams. Oxygen enters streams through atmospheric exchange, particularly in riffles, and from photosynthesis by aquatic plants and algae. The amount of dissolved oxygen varies with temperature and elevation, making certain habitats, such as spring-fed streams, crucial for maintaining stable oxygen levels year-round. Other environmental factors, such as habitat complexity, streamflow, and water quality, also play important roles in supporting healthy trout populations (Snyder et al., 2015).

Given their sensitivity to these factors, trout populations are a key focus in conservation efforts aimed at protecting cold-water habitats from the impacts of climate change and land-use activities. The goal of this project is to identify streams at risk of rising temperatures to guide conservation efforts and protect vital cold-water habitats (Snyder et al., 2015; Kirk et al., 2022).

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## Life Stages



**Brook trout** (*Salvelinus fontinalis*), Virginia's only native trout, are most vulnerable in late summer and winter.

They are highly sensitive to habitat fragmentation and warming trends, with the highest mortality occurring from July to September due to heat stress, low oxygen, and increased competition.

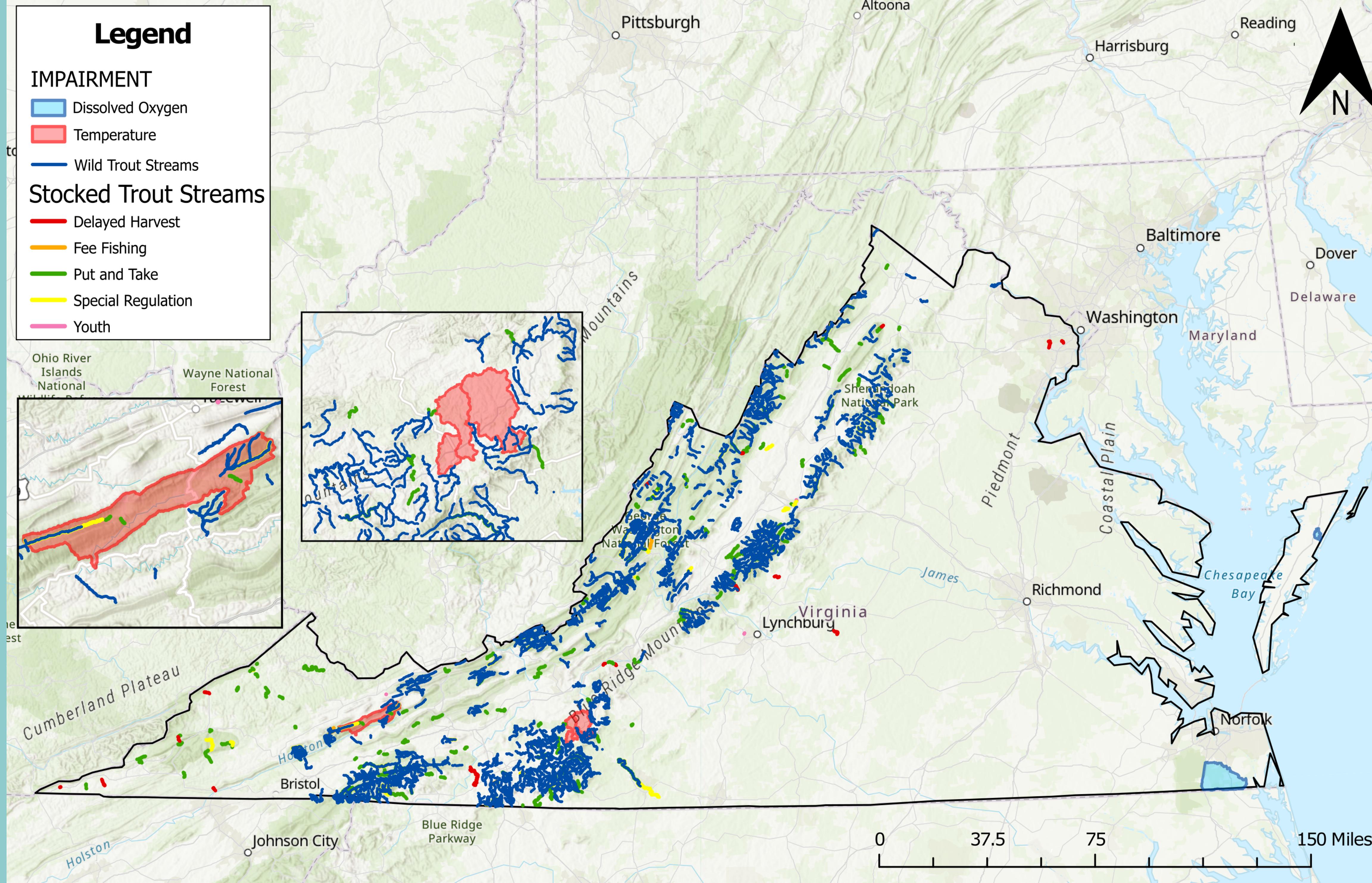
**Brown trout** (*Salmo trutta*), a non-native species, have a similar cycle to brook trout but with slightly later timing.

They are vulnerable to winter temperature fluctuations and sedimentation during egg development. While they tolerate higher temperatures than brook trout, they still rely on cold tailwater releases and deeper streams to survive Virginia's summer

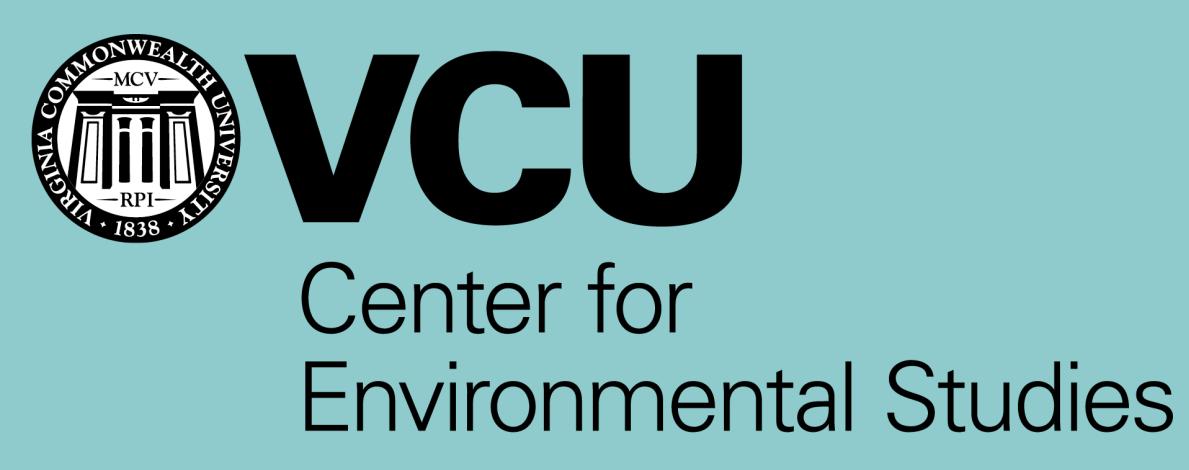
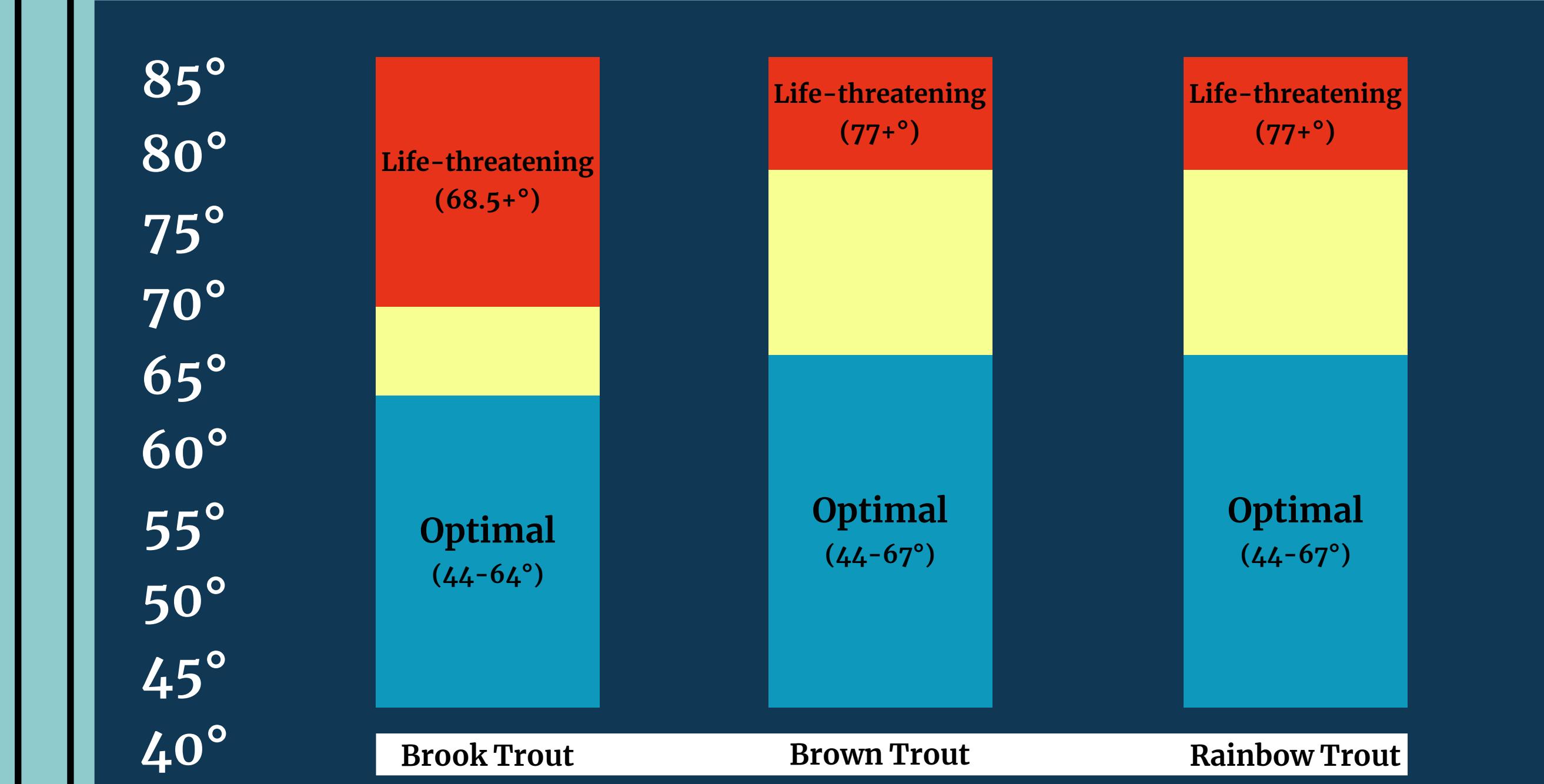
**Rainbow trout** (*Oncorhynchus mykiss*), another non-native species, are most vulnerable in spring and summer. Rising temperatures from May to August pose a risk to eggs and fry, while adults face heat stress and low oxygen from July to September. They rarely survive in lower-elevation waters without deep pools or groundwater influence.

The red-blue gradient on the chart represents the life stages of trout most likely to endure life-threatening conditions in Virginia.

## Virginia Trout Streams



## Optimal Temperatures



## Conclusion

Wild and stocked trout streams were found in temperature-impaired watersheds, highlighting the need for targeted conservation efforts to support both populations. Implementing riparian buffers in these areas would provide critical shading to help mitigate rising temperatures. These efforts align with Total Maximum Daily Load (TMDL) strategies, which aim to restore impaired waters by addressing factors such as temperature increases and habitat degradation (Snyder et al., 2015; Kirk et al., 2022). Forested watersheds, in particular, help buffer headwater streams from thermal degradation, making them essential for protecting cold-water species amid climate change (Kirk et al., 2022). Additionally, strategic land-use practices that reduce impervious surfaces could help minimize thermal pollution and runoff, further supporting trout habitats.

Based on the findings, current dissolved oxygen impairments do not appear to be significantly impacting trout streams; however, improved monitoring efforts are recommended to ensure long-term water quality. Strengthening conservation practices through monitoring and habitat restoration will be essential for sustaining trout populations and maintaining the health of Virginia's freshwater ecosystems.