What matters and what doesn't regarding low dissolved oxygen events in the Delaware Estuary?

Fanghui Chen, Ph.D., P.E.
Senior Water Resources Engineer
Delaware River Basin Commission

Partnership for the Delaware Estuary
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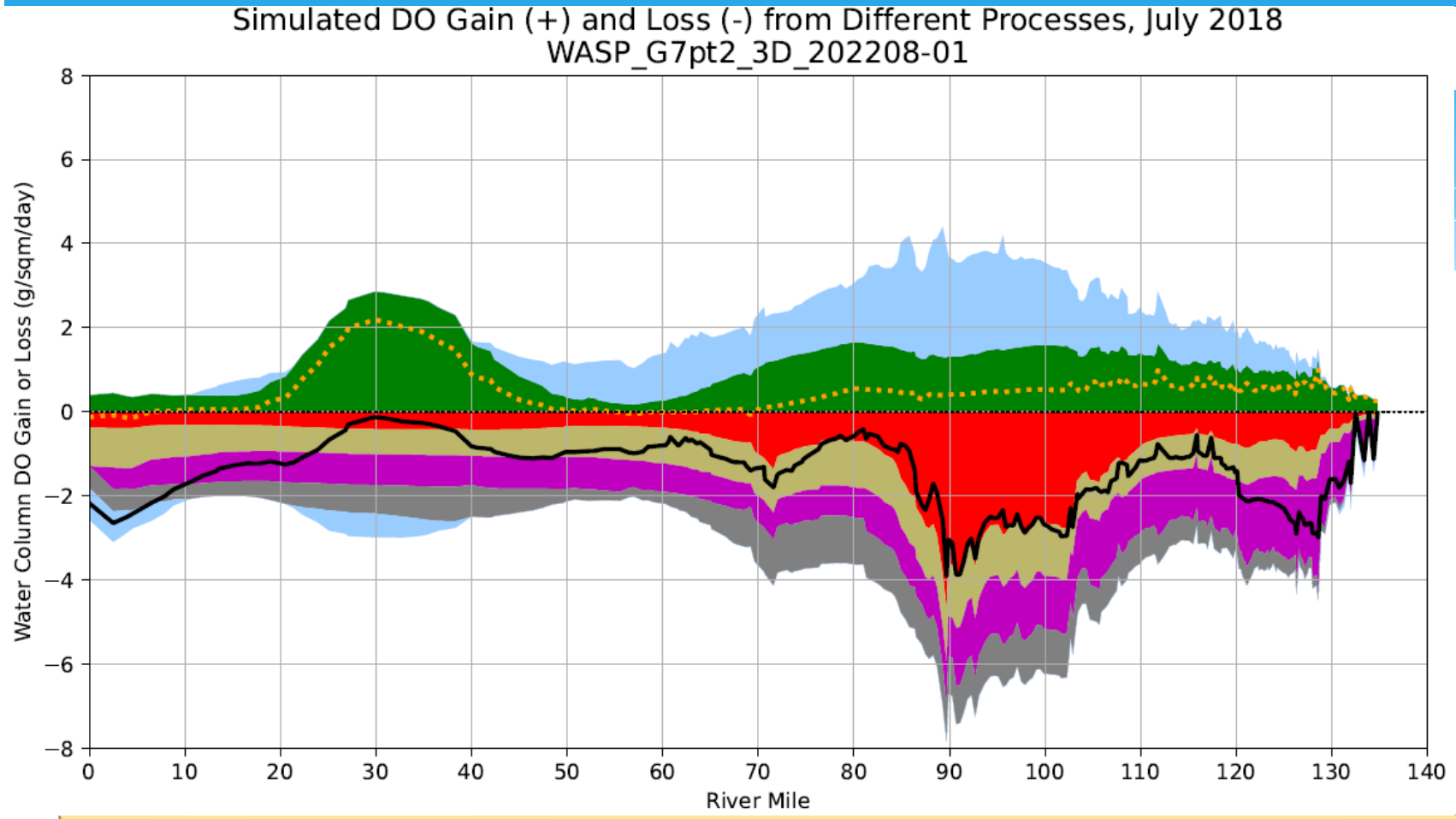
Understanding dissolved oxygen processes



DO Components Analysis

Algae Production
Reaeration

DO Production

Nitrification (loss)
CBOD Oxidation (loss)
SOD (loss)
Algae Respiration (loss)

DO Consumption

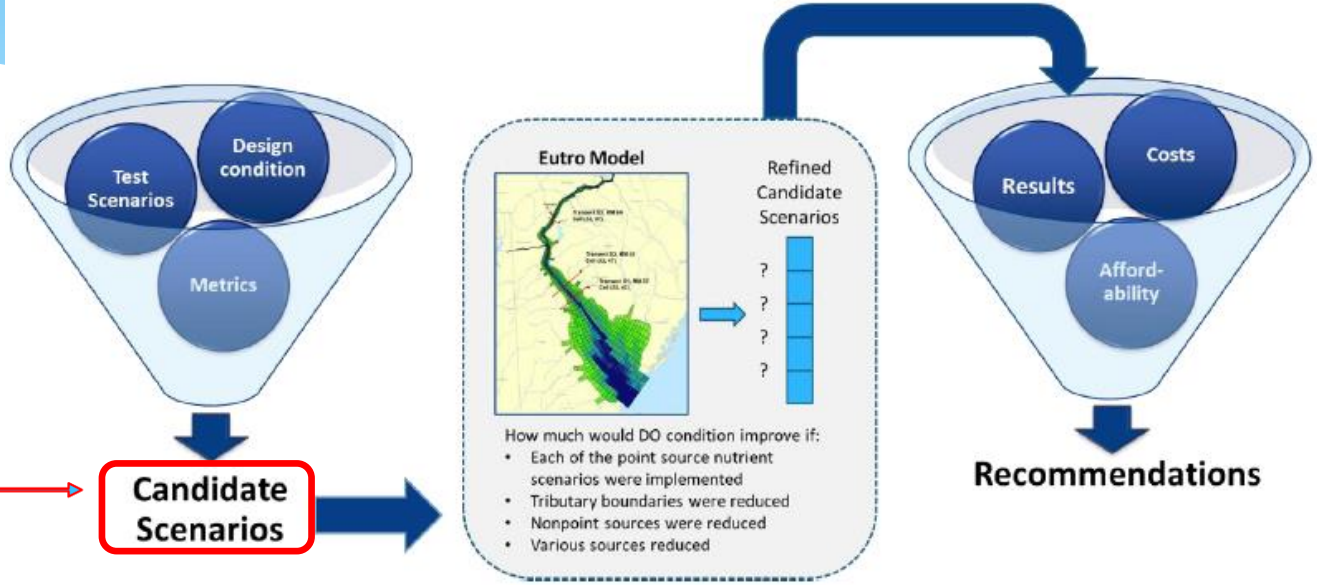
Net DO Flux
Net Algae Production

- ***Processes that control DO production: reaeration, photosynthesis.***
- ***Processes that affect DO consumption: nitrification, followed by SOD, CBOD oxidation, and respiration***
- ***DO gain from net algal production << DO loss caused by nitrification in the urban portion of the tidal river***
- ***Reaeration impacts can offset both sinks and sources***

Analysis of Attainability (AA)

- Design Condition, Source Sensitivity, Metrics

- ❑ Design Condition (baseline)
- ❑ Test Scenarios
  - ➢ Pollutant source sensitivity scenarios
  - ➢ Pollutant load reduction scenarios
- ❑ Metrics



Elements of analysis of attainability

Characterize the distribution, magnitude, frequency, and/or duration

"**Critical propagation season**": **from May 1 to October 15**

- Longitudinal Plots: DO Percentiles and "Percent-Above"
- DO Relative Stress Index
- Tabular Maps

This "summer" season reflects the temporal overlap between historically low DO events and important stages in juvenile development in which fish may be particularly vulnerable to low DO concentrations

AA: Design Condition

- **Hydrologic conditions** from 2012
  - tributary and watershed inflows and concentrations
  - tidal inputs at the mouth of the Bay and the C&D Canal
  - weather inputs
- **Permitted flow** rates for all point source (wastewater treatment plant) discharges
- Seasonal median **effluent concentrations** for wastewater discharges (current treatment levels)
- Post-channel deepening **bathymetry**

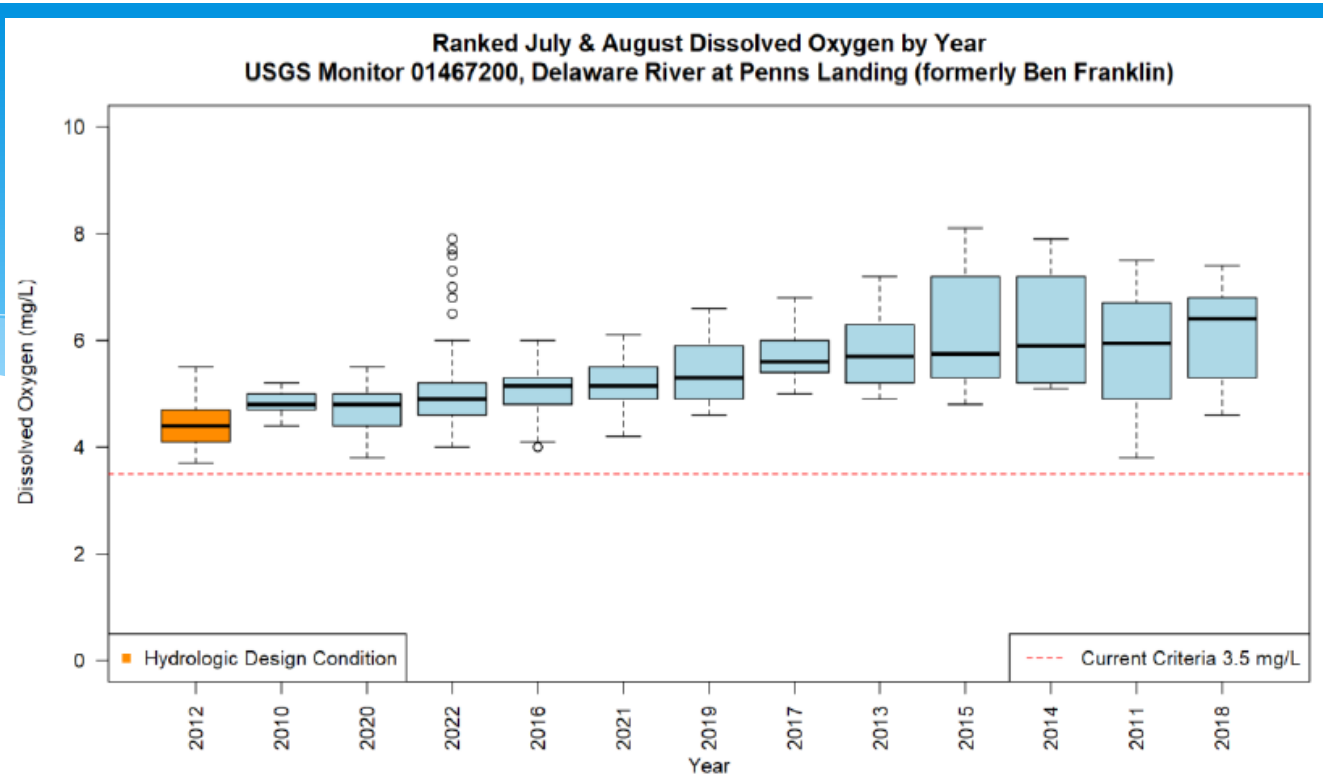


Figure 2-5: Dissolved oxygen at Penn's Landing during July and August from 2010–2022

DO in the Delaware River Estuary usually reaches its annual minimum in July and August period. 2012 showed lowest DO during 2010-2022 period. Low flow with dry-weather conditions brought lower DO in the summer of 2012.

Notes: The permitted flow rates established by individual NPDES permits.
"summer" (May–October) and "winter" (November–April) median values calculated based on model-interpolated concentrations assigned based on intensive data collection during the 2018–2019 calibration period.

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AA: Source Category Sensitivity Tests

Which pollutant sources to the Estuary may substantially impact DO improvement in the FMA?

- Wastewater Treatment Plants
- CSOs
- Non–point sources (NPS)
- Municipal separate storm sewer systems (MS4)
- Tributaries

Source constituents

NH34, TN, P, CBOD, DO, etc.

FMA: the fish maintenance area, which covers Zone 3, 4, and upper Zone 5, roughly from RM 70 to near RM 108

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Source category sensitivity tests

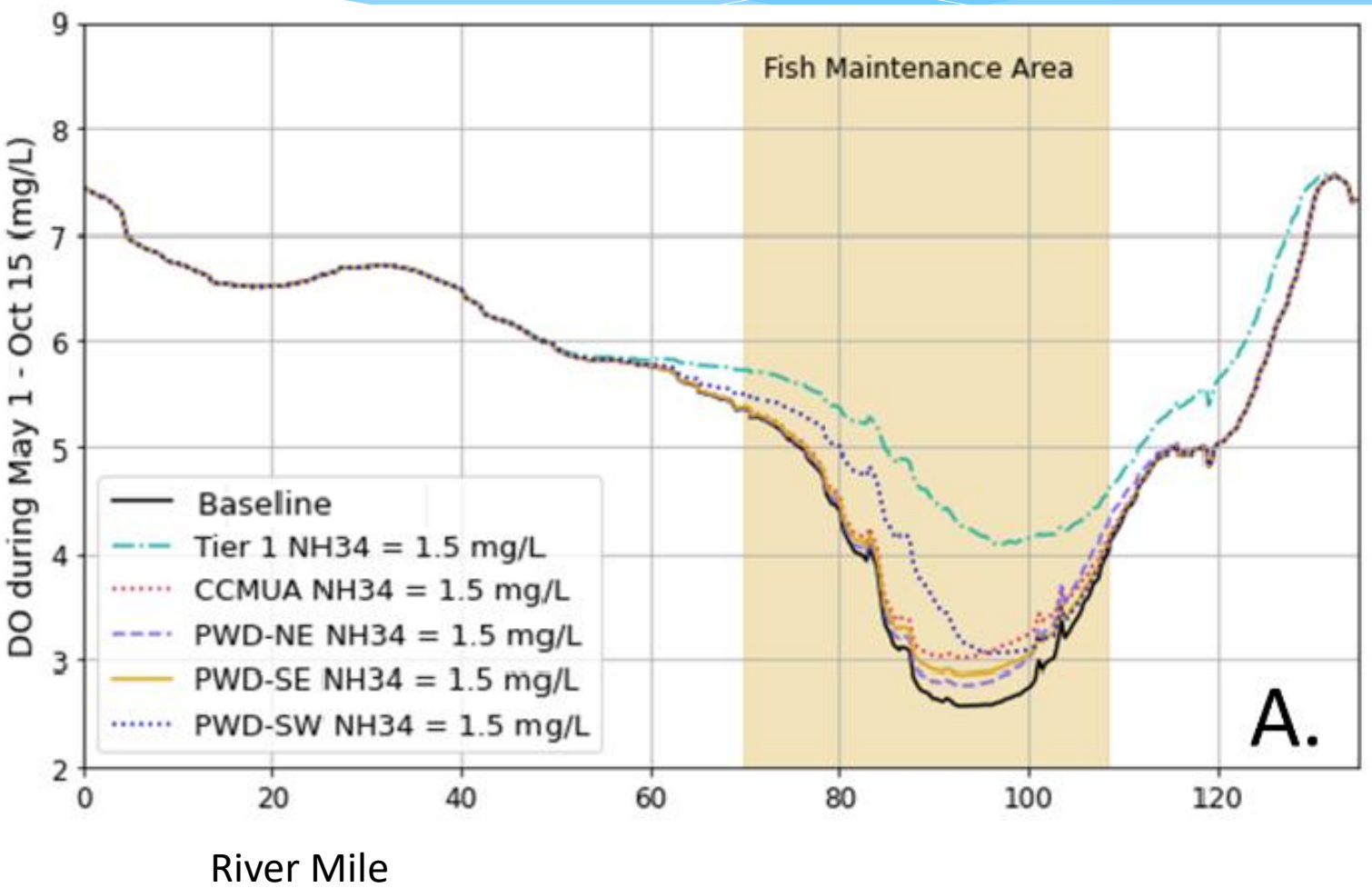
Results from sensitivity tests are compared to the Baseline scenario

Individual wastewater discharge NH34 reduced to 1.5 mg/L

1st Percentile DO

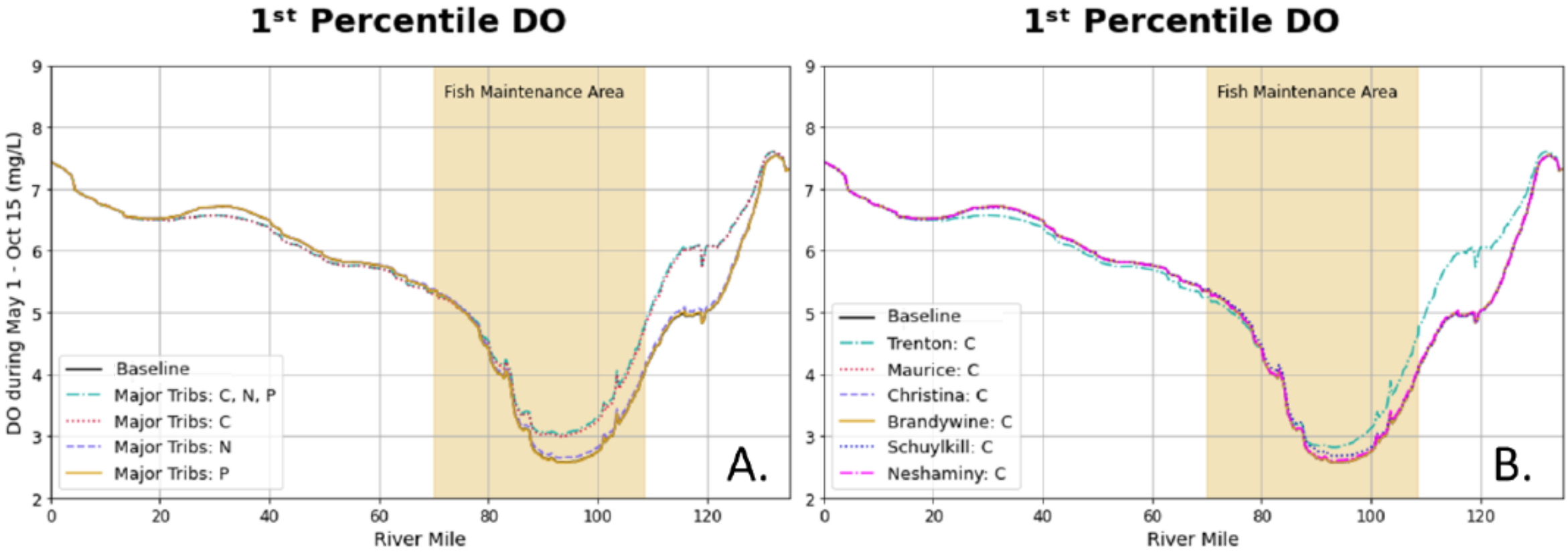
Reducing effluent ammonia loads from these discharges resulted in substantial DO improvement in the FMA

Note: Tier 1 discharges were identified based on two years of effluent loading data collected during the 2010s; the Tier 1 discharges together constitute 95% of total point source nutrient load



Tributary Sensitivity Tests

C, N, and P set to minimal concentrations in 6 major tributaries:
(Maurice, Christina, Brandywine, Schuylkill, Neshaminy, Delaware @Trenton)



A. Four test scenarios where C, N, and/or P from six major tributaries (Delaware River at Trenton, Schuylkill River, Maurice River, Christina River, Brandywine Creek, and Neshaminy Creek) were set to minimal values. **B**. Six test scenarios where C was reduced from each major tributary individually.

Factors That Can Improve Dissolved Oxygen In Fish Maintenance Area

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Factors that can most improve DO in the FMA	Factors that can slightly improve DO in the FMA	Factors that cannot measurably improve DO in the FMA
▪ **Summer (May–Oct) ammonia loads from specific point-source discharges** ▪ Carbon loads from Delaware River at Trenton (high % of total flow)	▪ Combined sewer overflows (CSOs) ▪ DO concentration in treated effluent from the largest point-source discharges ▪ Carbon loads from Schuylkill River	▪ Nutrient (C, N, P) loads from tributaries, except C loads from Delaware River at Trenton and Schuylkill River ▪ Winter (Nov–Apr) ammonia, CBOD, and TN from all point-source discharges ▪ Summer (May–Oct) ammonia loads from many point-source discharges ▪ Direct stormwater runoff into the Delaware Estuary

Improving Dissolved Oxygen and Aquatic Life Uses in the Delaware River Estuary

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Topic	Presenter
Why are we here?	Steve Tambini
How did DRBC address low dissolved oxygen in the Delaware Estuary - then and now?	Namsoo Suk
Where do ammonia and other nutrients in the Delaware Estuary originate, and how do we know?	John Yagecic
What is this estuary-wide eutrophication model and why do we need it?	Li Zheng
What matters and what doesn't with regard to low dissolved oxygen events in the Delaware Estuary?	Fanghui Chen
What combination of wastewater improvements will achieve the best dissolved oxygen outcome in the Delaware Estuary?	**Sarah Beganskas**
What is the highest attainable dissolved oxygen condition in the Delaware Estuary, and what will it mean for aquatic life uses?	Thomas Amidon
Q&A Panel: Enhancing support for aquatic life uses in the Delaware Estuary	**All**