Modeling Eutrophication Processes in the Delaware Estuary to Link Watershed Efforts to Control Nutrient Impacts

Delaware Watershed Research Conference

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Principal Investigators:
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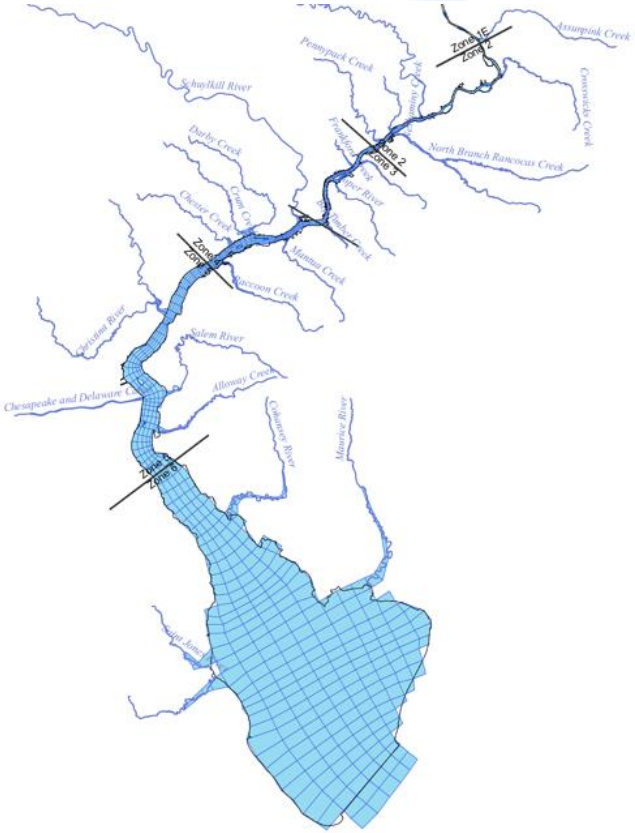

Presentation Outline

- Problem Statement
  - History of water quality issues in the Delaware Estuary
    - Dissolved Oxygen (DO)
  - Designated and Existing Aquatic Life Use and Water Quality Criteria
- Methodology
  - Data collection / evaluation
  - Model development
- Next Steps

Water Quality Regulations

Water Quality Standards

Designated Uses:

e.g., water supply, protection and propagation of aquatic life, recreation in and on the water.

Criteria:

numeric and/or narrative parameters to protect the designated uses.

Antidegradation Policy And Procedures:

to maintain and protect existing water quality.

Background

- The estuary consists of five water quality management units called “Zones”.
- DRBC established water quality standards (“stream quality objectives”) for the Estuary in 1967.
- In 1968, the DRBC adopted regulations including wasteload allocations for oxygen-demanding pollutants for Zones 2 – 5.

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Designated Uses in Current DRBC Regulations since 1967

Zone	River Mile	Aquatic Life Use	Migratory Fishes
2	108.4 – 133.4	**maintenance** and **propagation** of resident fish and other aquatic life	**passage** of anadromous fish
3	95 – 108.4	**maintenance** of resident fish and other aquatic life	**passage** of anadromous fish
4	78.8 – 95	**maintenance** of resident fish and other aquatic life	**passage** of anadromous fish
5	70 – 78.8	**maintenance** of resident fish and other aquatic life	**passage** of anadromous fish
	48.2 – 70	**maintenance** and **propagation** of resident fish and other aquatic life	**passage** of anadromous fish
6	0 – 48.2	**maintenance** and **propagation** of resident fish and other aquatic life **maintenance** and **propagation** of shellfish	**passage** of anadromous fish

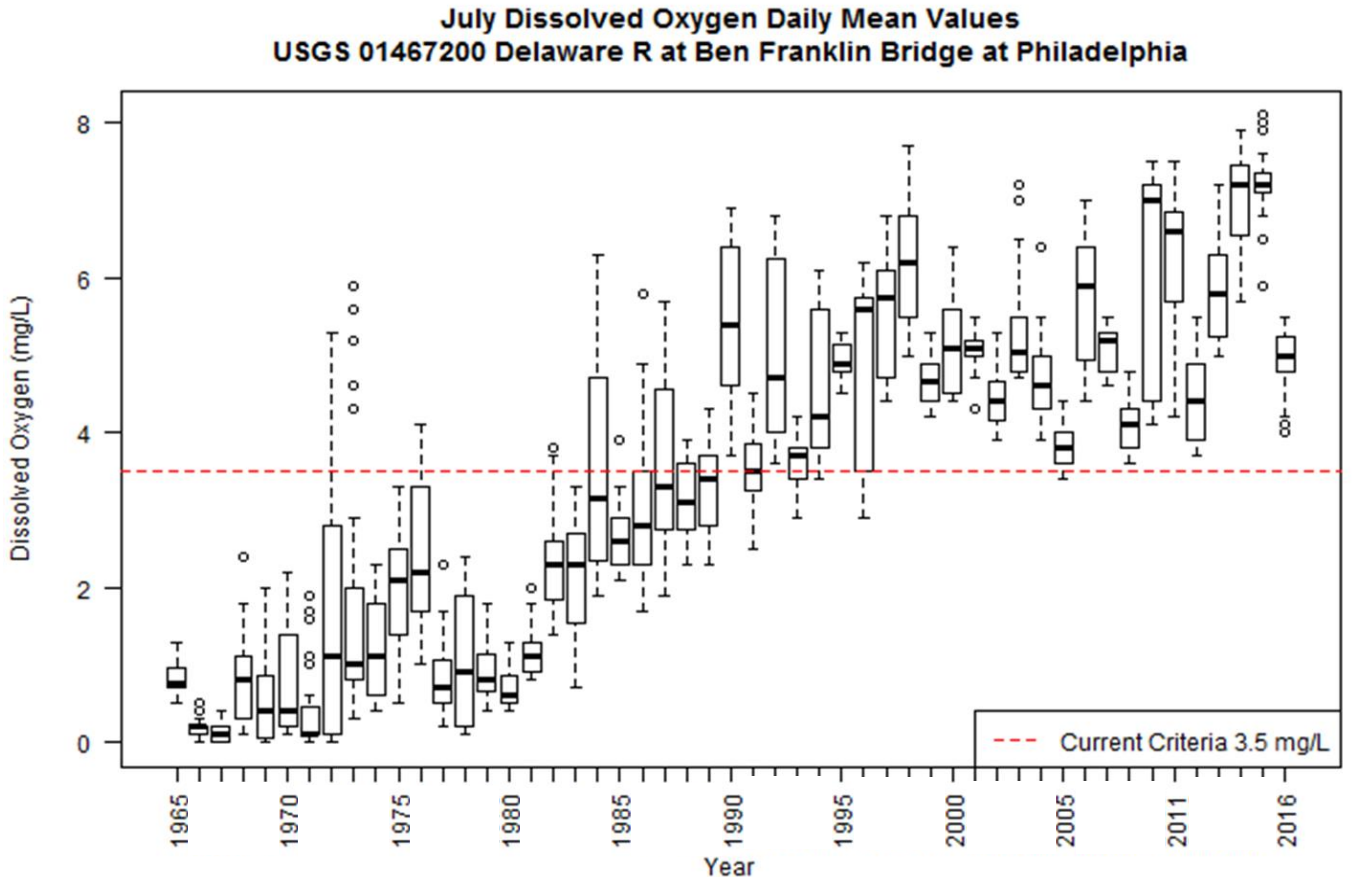
DRBC Evaluation of Existing Use (2015)

Key Findings

- The goals established in 1967 through DRBC's designated uses have been exceeded, at least in part, by the successful restoration of dissolved oxygen to 3.5 mg/L as a daily average concentration.
- Data collected in Zones 3, 4 and upper Zone 5 indicate at least some degree of propagation has been observed.
- Full attainment of propagation has not been demonstrated at this time based on the data available and examined for this evaluation.

What's Next?

What should the water quality standards be for the WQ Zones in the Delaware River Estuary?



Daily Mean Dissolved Oxygen in July

USGS 01467200 Delaware R. at Ben Franklin Bridge at Philadelphia

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Key Questions

1. What water quality criteria must be achieved to protect target fish species and life stages?
2. What impacts will any proposed changes have on endangered species?
3. What seasonal, geographic and/or temporal conditions must be considered along with any suggested changes to related water quality criteria?
4. What are the estimated oxygen demand and nutrient (pollutant) loadings from point and non-point sources in the Estuary today?
5. What total wasteload and load allocations must be achieved to protect target species?
6. How and to whom will loads be allocated?
7. What are the capital and operating costs of technologies to achieve higher levels of dissolved oxygen in the Estuary?
8. What physical, chemical, biological, social and economic factors will affect the attainment of the water quality standards?

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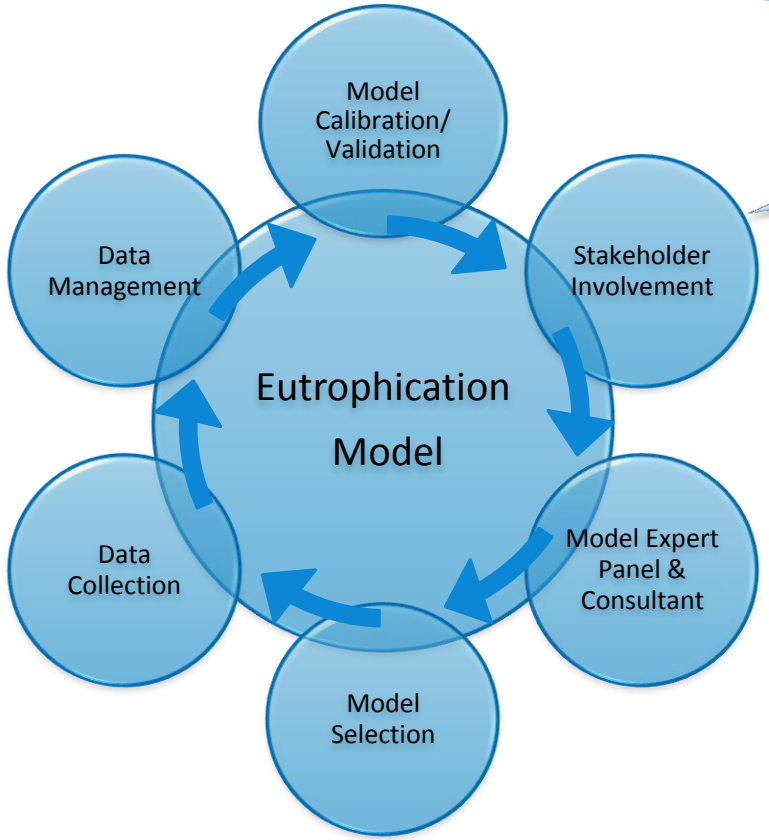
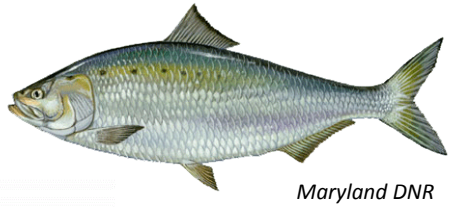


Management Options (technical & economic)

Implementation

Revised Water Quality Standards



Maryland DNR

Joseph Tomelleri

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Completed and On-going Tasks

- Modeling Staff, Dr. Li Zheng was hired in October 2016
- The model expert panel met twice: November 2016 and July 2017
  - Members: Carl Cerco, Steve Chapra, Bob Chant, and Tim Wool
- Contracted with the modeling consulting firm, LimnoTech in April 2017 lead by Dr. Vic Bierman
- Outreach Effort
  - DRBC Water Quality Advisory Committee met in May and August 2017
  - The Regulated Community (point source dischargers) met in October 2017

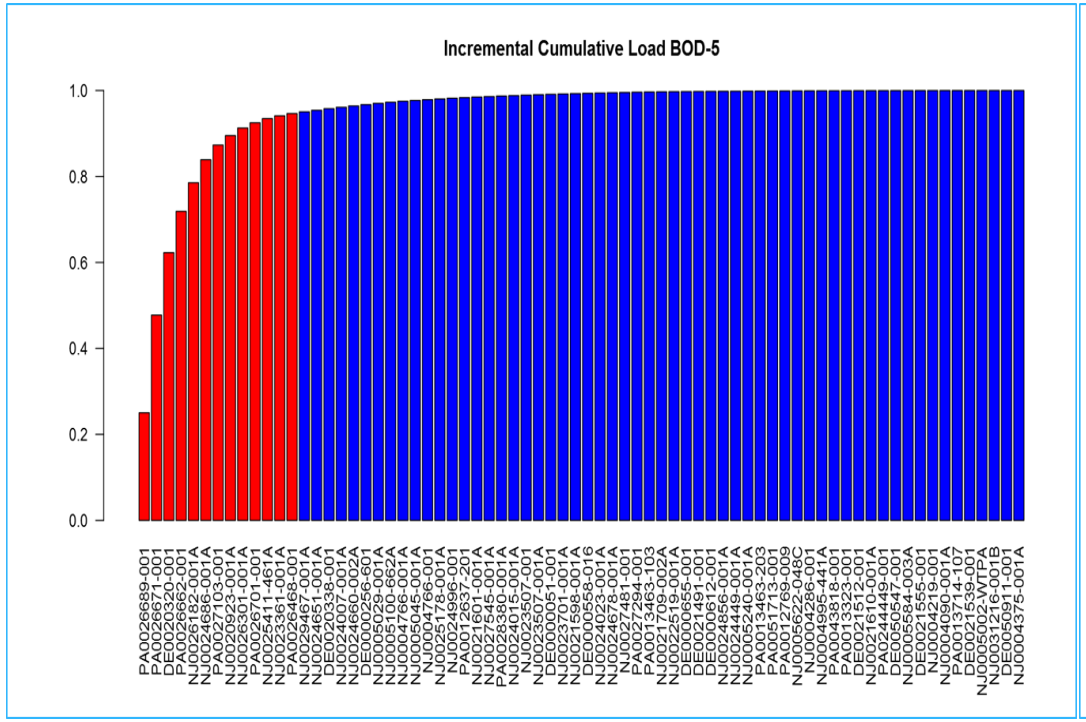
Related Monitoring

- Year-round, monthly monitoring at 22 stations in mainstem estuary (2017 – 2019)
  - Monitored March to October in 1960s ~ 2016
- Two-year point source discharge effluent monitoring (2011 – 2014; 2018 - 2019)
- Year-round, bi-weekly monitoring for
  - Delaware River at Trenton (2017 – 2019)
  - Schuylkill River (2018 – 2019)
- Quarterly monitoring for ten (10) tributaries (2016 -2017)
  - Will expand to monthly for growing season ~20 tributaries (2018 -2019)[1]
- Enhancement of existing gages
  - Water temperature and salinity for Lewes; Cape May; Chesapeake City NOAA stations (April 2017 – 2019)
    - Data Link: https://tidesandcurrents.noaa.gov/ports/index.html?port=db
  - Nitrate sensors for Trenton and Chester USGS stations (2018 – 2019)

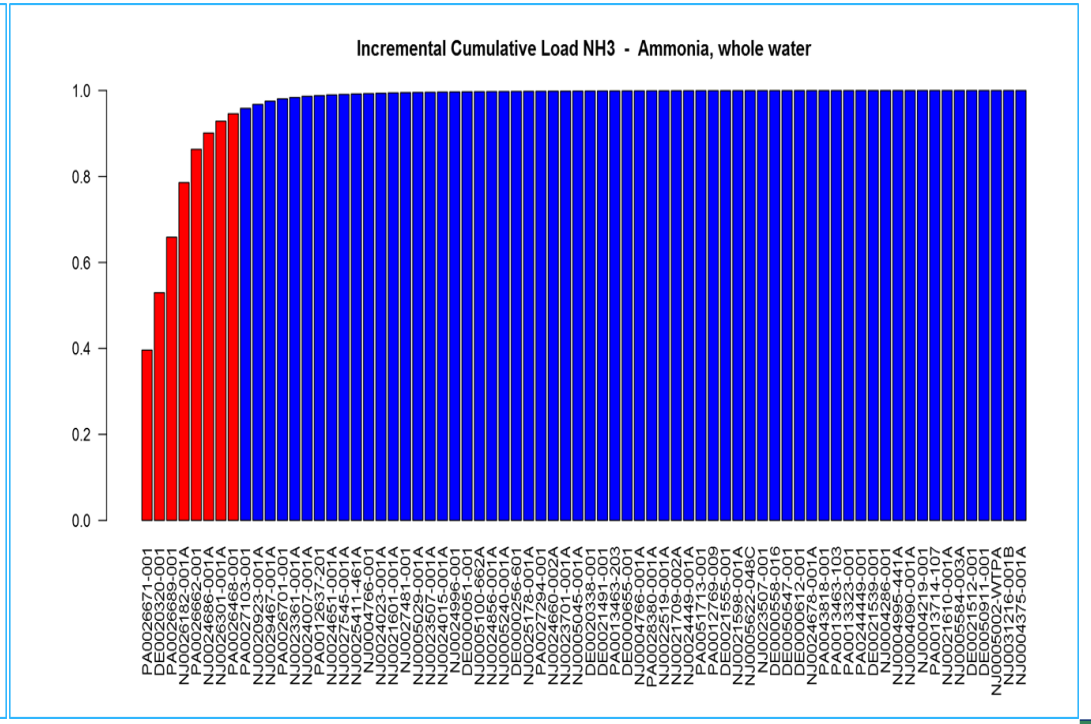
[1] Partially funded by DWRF

Cumulative Loads from Continuous Point Source Discharges from two-year data (2011 -2014)

BOD5



Ammonia-N



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Cumulative Loads from Continuous Point Source Discharges from two-year data (2011 -2014)

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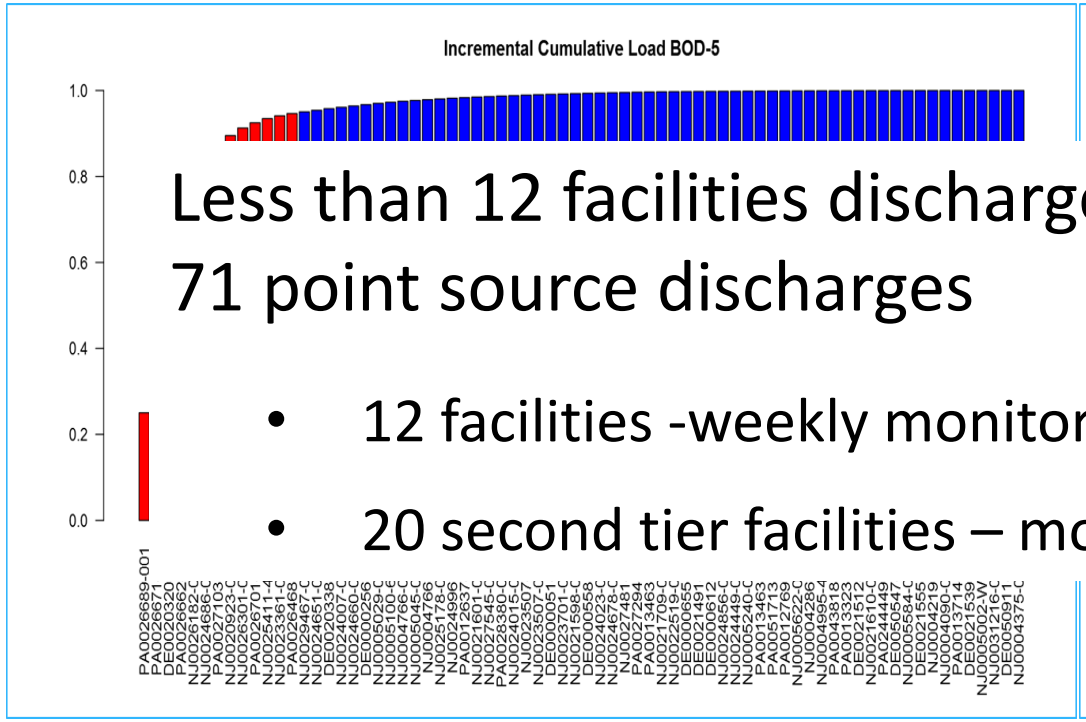

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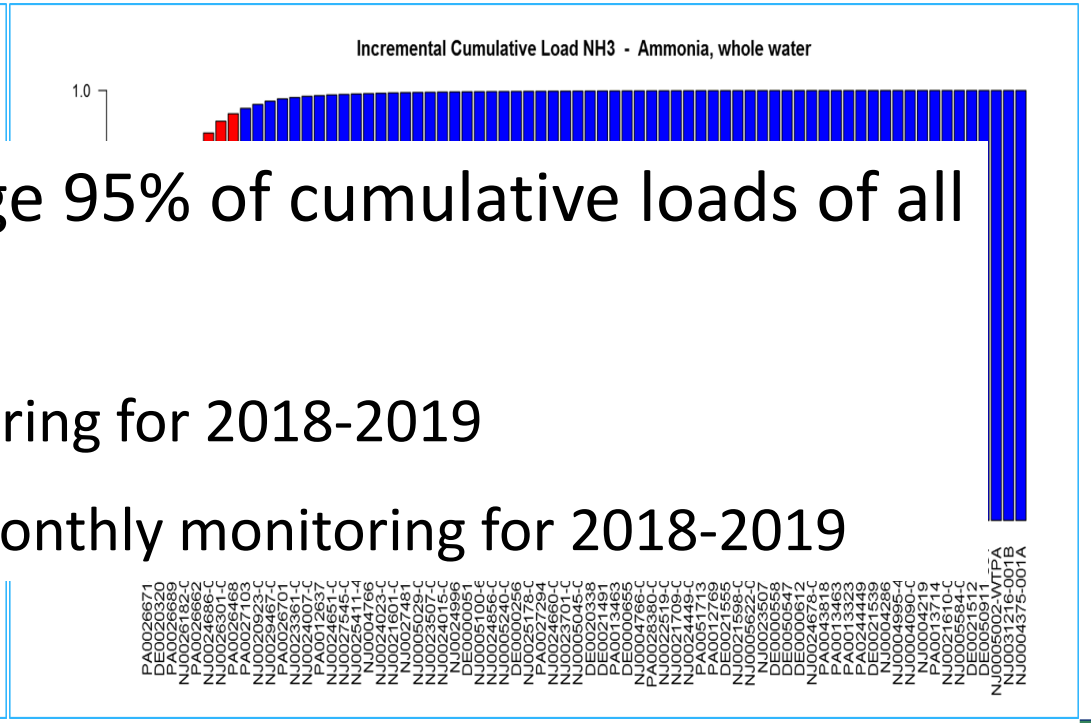

Less than 12 facilities discharge 95% of cumulative loads of all 71 point source discharges

- 12 facilities -weekly monitoring for 2018-2019
- 20 second tier facilities – monthly monitoring for 2018-2019

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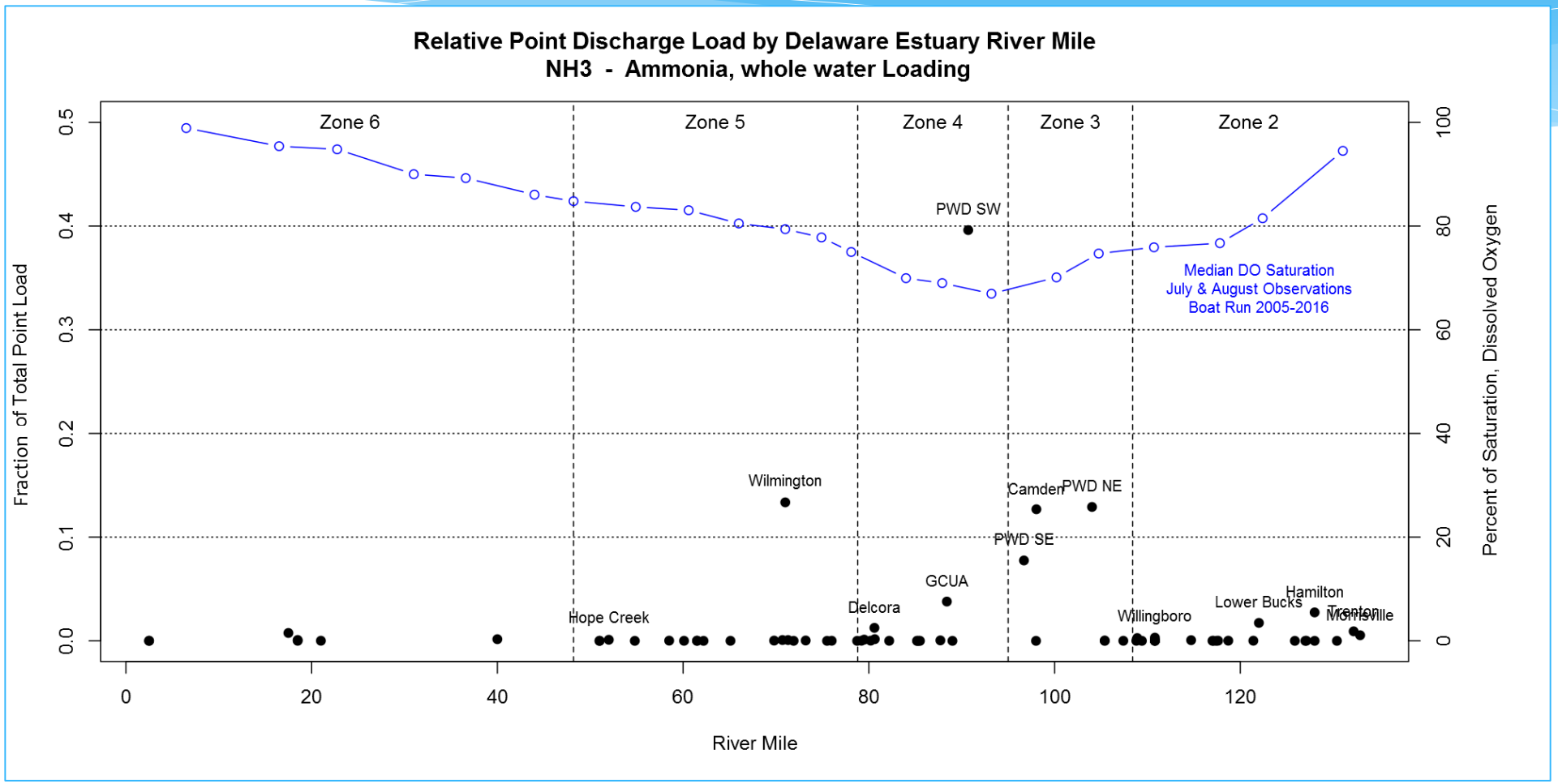
Ammonia Percent of Total Point Load by River Mile



Model Selection Consideration
from November 2016 Model Expert Panel Meeting

- Hydrodynamic model capability
  - Wet-drying
  - Overall CPU time
- Readily available water quality model
  - Multiple algae and sediment diagenesis
- Technical support availability

- Two levels of models
  - Use the existing 1-D DYNHYD5 hydrodynamic model linking with WASP8 as a screening level model → found linkage issues
  - Use the existing 3-D CH3DZ hydrodynamic model linking with WASP8 as a full scale model

Final Selection of Models

Hydrodynamic

- Environmental Fluid Dynamics Code (EFDC) for both screening and complex levels
- Built-in linkage with WASP

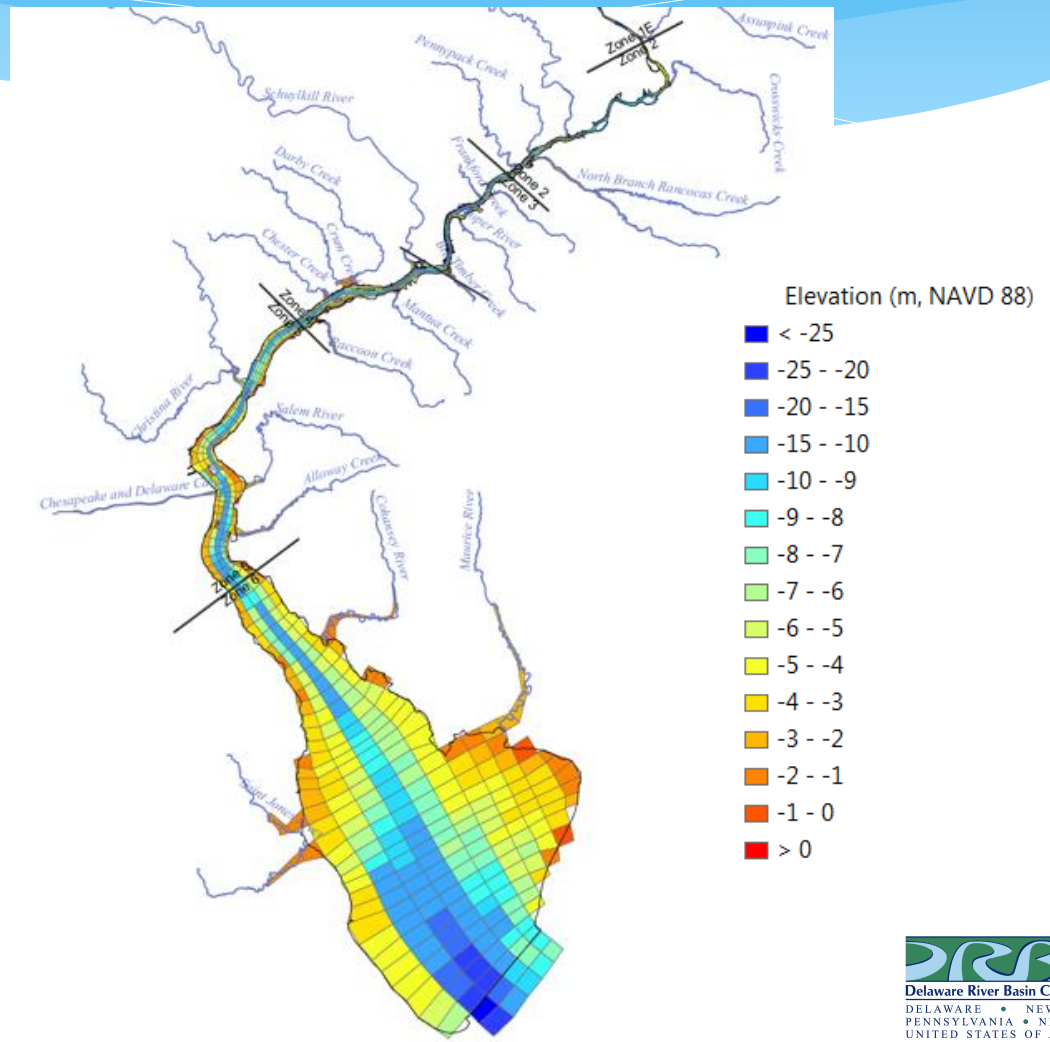
Water Quality (Eutrophication)

- Water Quality Analysis Program (WASP) version 8
- US EPA supported

- Applied to a wide range of environmental studies
- Model domain includes entire Delaware River Estuary and Bay

Two-Dimensional EFDC Hydrodynamic Model (Screening Level Model)

- Model Domain:
  - Delaware River at Trenton to near the mouth of the Bay
  - Twenty-four tributaries up to DRBC monitoring locations
- Number of grid cells: 897
  - Average grid size
    - 1,340 m in longitudinal direction
    - 1,370 m in lateral direction
- Bathymetry data
  - Main Stem: DEM from FEMA and USACE (2011)
  - Tributary: NOAA nautical charts 12311 ~ 12314
  - NAVD88 datum



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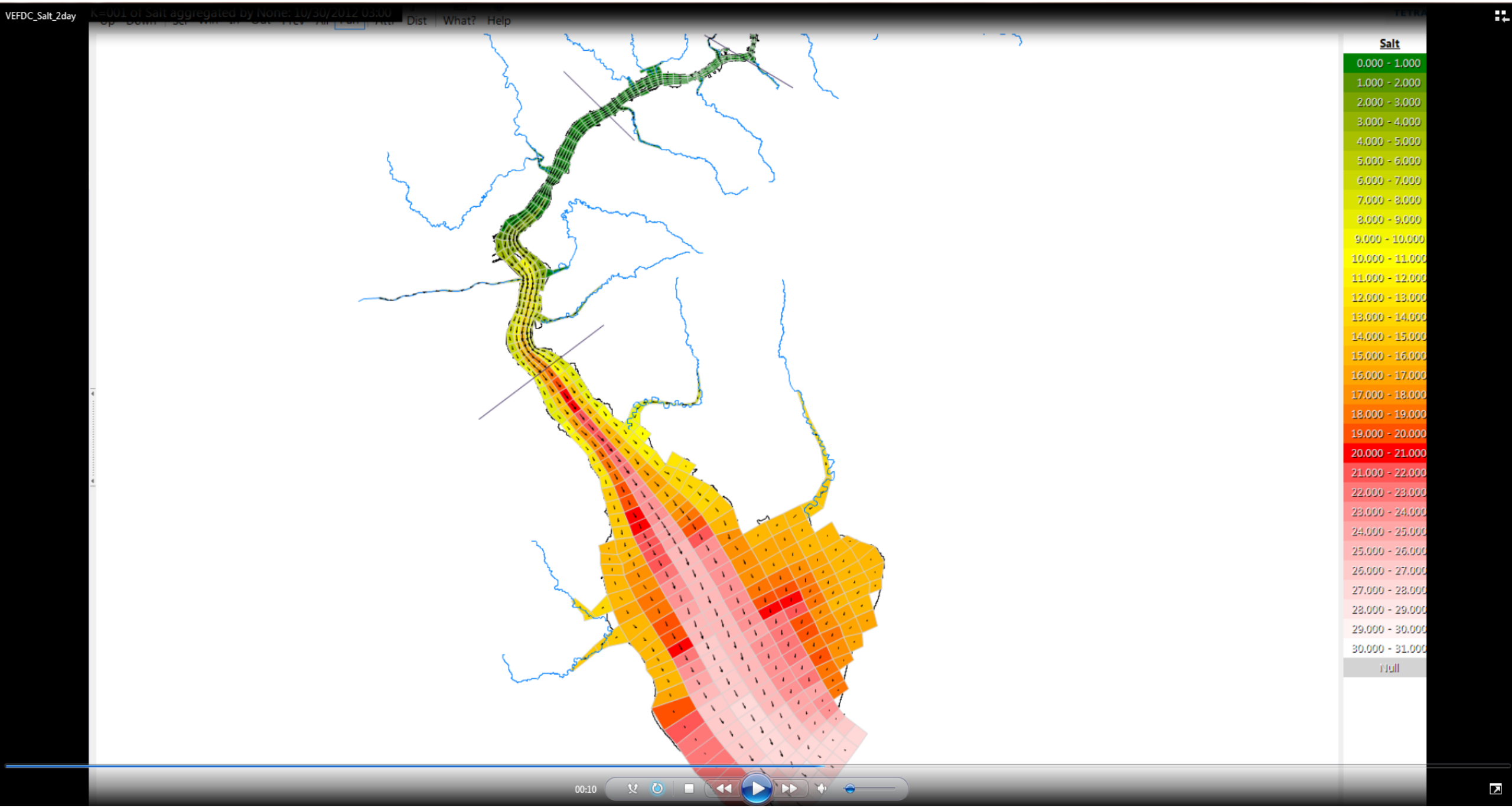
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Next Steps

Model Development

- Continue development of 2-D EFDC hydrodynamic model
- Link with WASP8 eutrophication model
- Calibrate for 2012-2013 period

Data Collection / Compilation

- Monthly tributary monitoring ~20 locations
- Point source discharges monitoring
- Bi-weekly monitoring at two major upstream boundaries
- Meteorological data, inflows, currents and tides

DRBC Team Contact Information

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