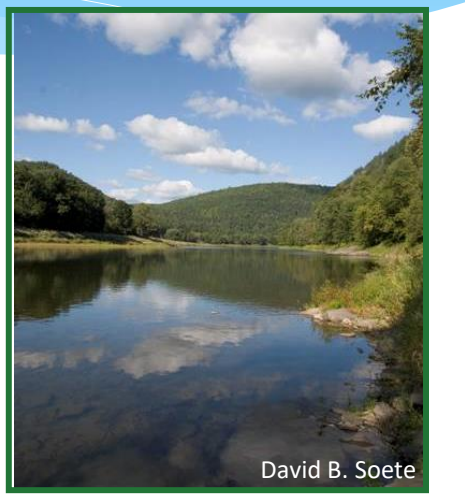
DELAWARE RIVER BASIN COMMISSION

Designated Use for Aquatic Life in Delaware River

Namsoo Suk, Ph.D.
Director, Science and Water Quality Management

Interstate Council on Water Policy
62nd Annual Meeting, Philadelphia
October 13, 2021



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Presentation Outline

- Delaware River Basin and Commission
- Study Area
- Project Goal
- On-going studies and “Analysis of Attainability”
- Lessons Learned so far
- Summary

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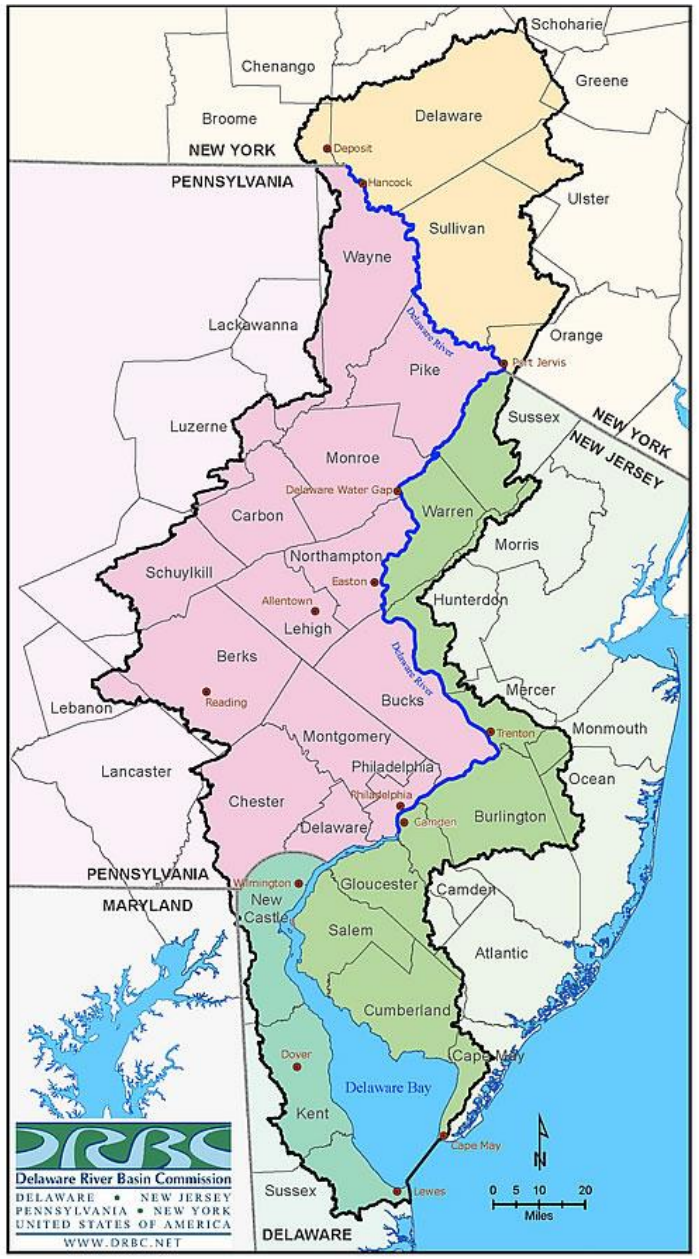
Federal interstate compact agency established in 1961:

DRBC:

- Delaware
- New Jersey
- Pennsylvania
- New York
- Federal Government

Broad Responsibilities for:

- Water Supply
- Drought Management
- Flood Loss Reduction
- Water Quality (Pollution Control)
  - Establish Water Quality Standards
  - Monitoring & Assessment
  - Load Reductions
- Watershed Management
- Regulatory Review (Permitting)
- Outreach/Education
- Recreation



"A river is more than an amenity, it is a treasure"

-US Supreme Court Justice
Oliver Wendell Holmes

Fast Facts:

- Delaware River Main stem river is **330 miles long**
- Delaware River forms an interstate boundary over its entire length
- **Over 13 million people** (about 5% of the U.S. population) rely on the waters of the Delaware River Basin
- **Drains 13,539 square miles** of watershed in 4 states.
- Water **withdrawal** in the Basin = **6.6 billion gallons a day**
- **Significant Exports: NYC (up to 800 MGD) and NJ (up to 100 MGD)**
- Longest, un-dammed U.S. river east of the Mississippi (dams are located on tributaries, not the main stem Delaware)
- **Contributes over $21B in economic value** to the Region.

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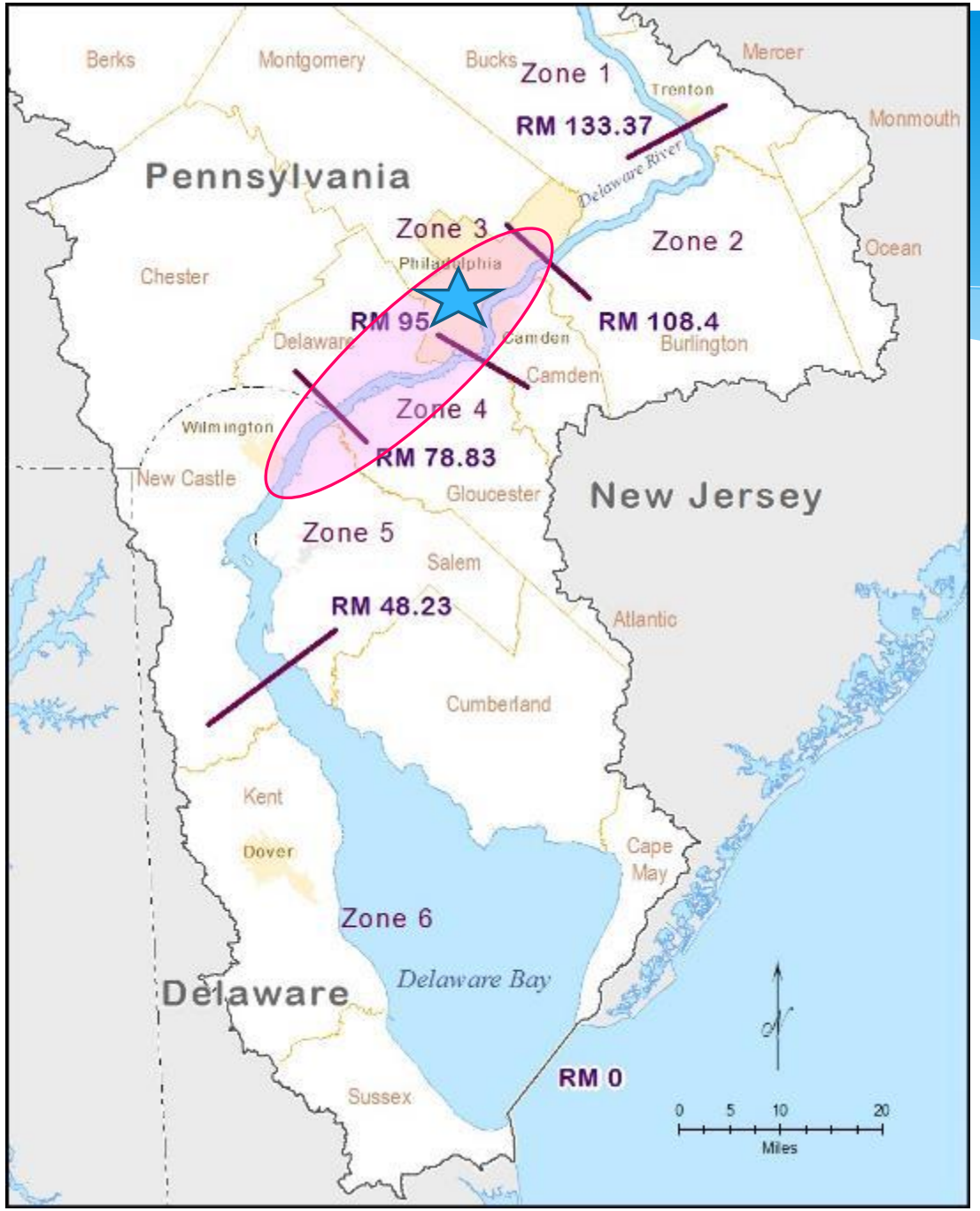

Delaware River Estuary

WQ Assessment Units:

Zone 1: Non-tidal (Upstream from Trenton)

Estuary:

Zone 2 - 5: Tidal Delaware River

Zone 6: Delaware Bay

River Miles:

RM 0.0 = Atlantic Ocean

RM 70 = City of Wilmington

RM 100 = Ben Franklin Bridge, Philadelphia/Camden

RM 133 = "Head of Tide", Trenton, NJ

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Dissolved Oxygen (DO) and Fisheries in Urbanized Delaware River Estuary

- The water quality goals established in 1967 have been exceeded
  - Dissolved oxygen exceeds 3.5 mg/L as a 24-hour average concentration
  - Use in urban area designated for “maintenance only”
- Fisheries enhanced due to improved dissolved oxygen condition*
  - Some degree of propagation has been observed
  - Full attainment of propagation has not been demonstrated

*https://www.nj.gov/drbc/library/documents/ExistingUseRpt_zones3-5_sept2015.pdf

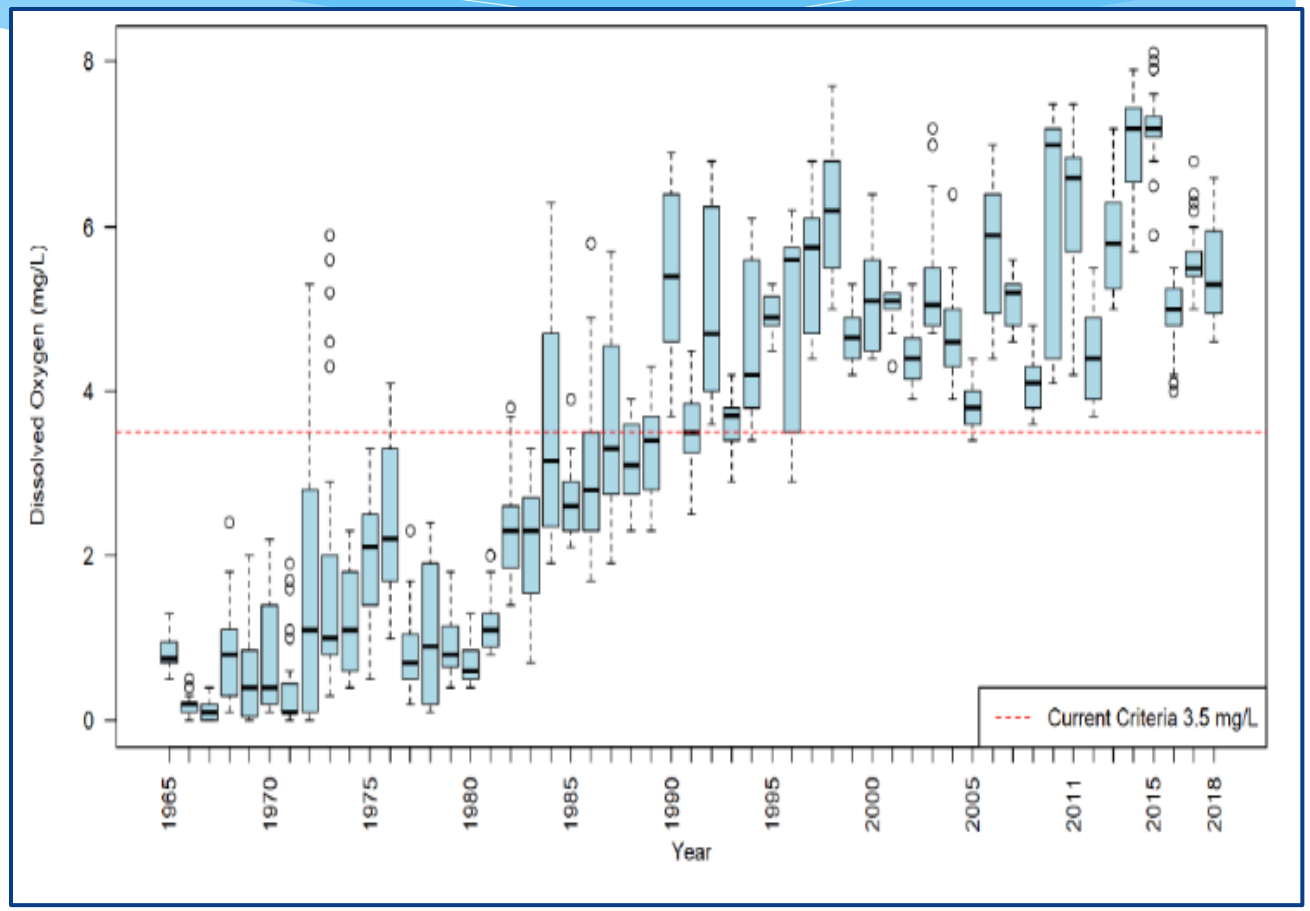
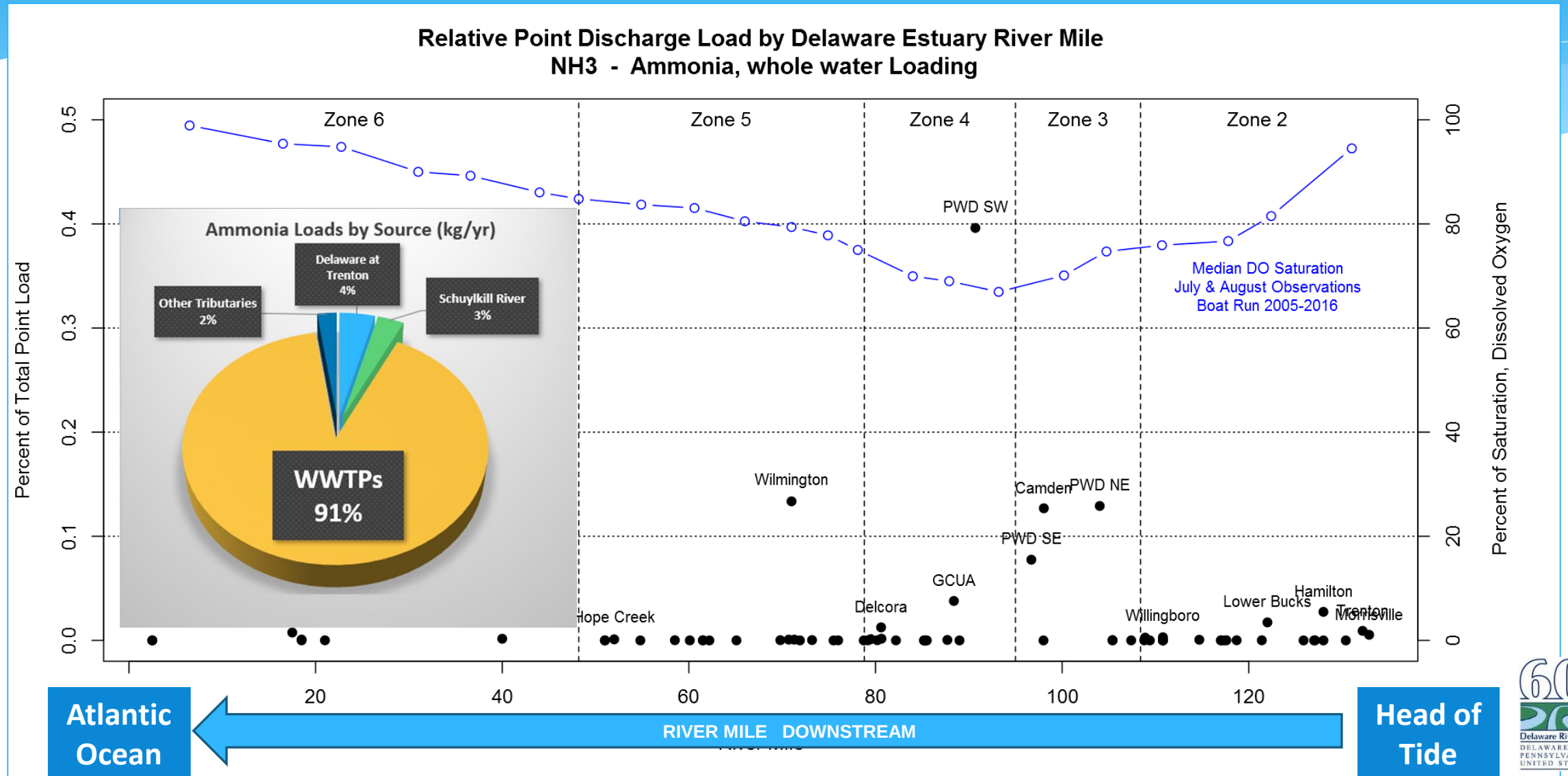


Figure: July & August DO by year (USGS 01467200: Delaware River at Ben Franklin Bridge)

Understanding the Problem



DRBC Resolution 2017-04
Studies Required Before Rulemaking

Fish/DO Studies

- 6(a). Input on the **dissolved oxygen requirements of aquatic species**
- 6(b). Field studies of the occurrence, spatial and temporal distribution of the life stages of Estuary fish species
- 6(c). Input from consultations pursuant to the **Endangered Species Act** ("ESA")

Modeling Studies

- 6(d). Development and calibration of a **eutrophication model** for the Delaware River Estuary and Bay;
- 6(e). Determination of the nutrient **loadings from point and non-point sources** necessary to support key aquatic species;

Cost/Feasibility Studies

- 6(f). Evaluation of the **capital and operating costs for treatment** capable of achieving higher levels of dissolved oxygen;
- 6(g). Evaluation of the physical, chemical, biological, **social and economic factors affecting the attainment of uses**,

6. "Analysis of Attainability"

6(h). Preparation of a **draft report and final report** containing findings and conclusions.

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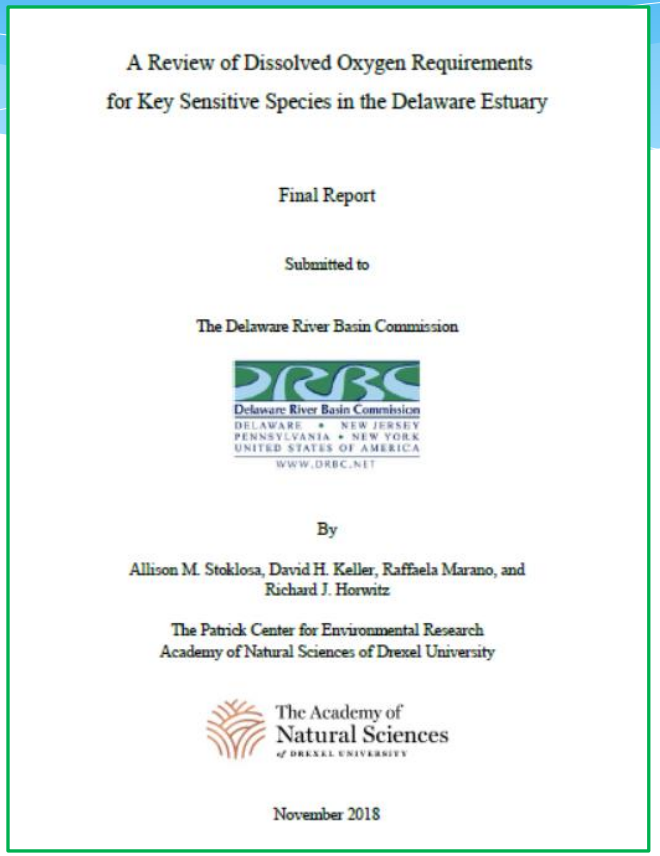
Fish / DO Studies

- Contracted with Academy of Natural Sciences-Drexel University (completed).
  - Summarized available literature and data on DO sensitivity for 14 fish and invertebrates at different life stages, locations, and seasons within the Delaware Estuary.
- Ichthyoplankton survey by PSEG (completed):
  - Samples were collected across 7 events in 2018 (April - July) in 14 zones ranging from the mouth of the Bay to Trenton, NJ.
  - DRBC funded the collection of 3 additional samples per event from one zone that was under-sampled (roughly C&D canal to Wilmington).



A Review of Dissolved Oxygen Requirements
for Key Sensitive Species in the Delaware Estuary

Final Report

Submitted to

The Delaware River Basin Commission

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WWW.DRBC.NET

By

Allison M. Stoklosa, David H. Keller, Raffaela Marano, and Richard J. Horwitz

The Patrick Center for Environmental Research
Academy of Natural Sciences of Drexel University

The Academy of Natural Sciences of DREXEL UNIVERSITY

November 2018

https://www.nj.gov/drbc/library/documents/Review_DOreqKeySensSpecies_DelEstuary_ANStoDRBCnov2018.pdf

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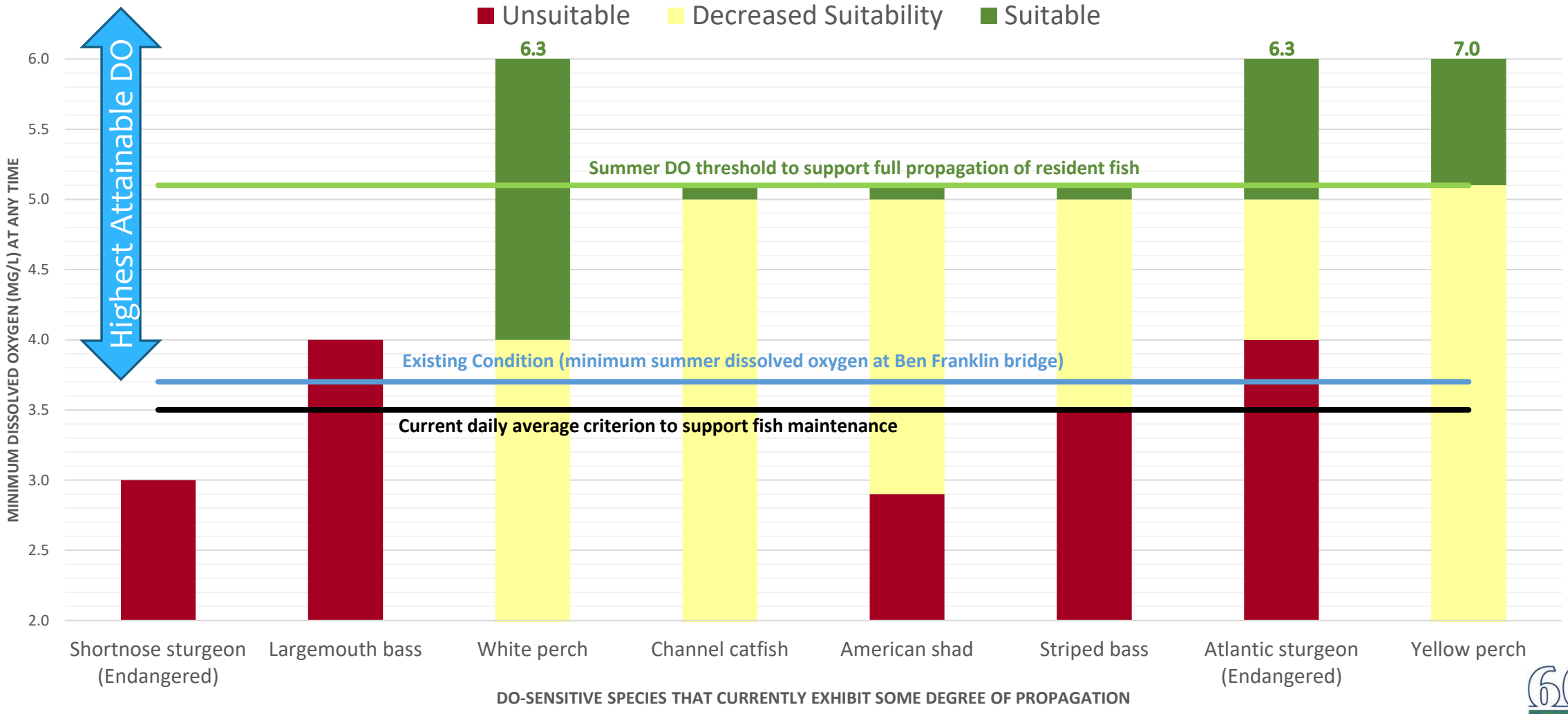
Conceptual Model Applied to Zone 3 in Summer



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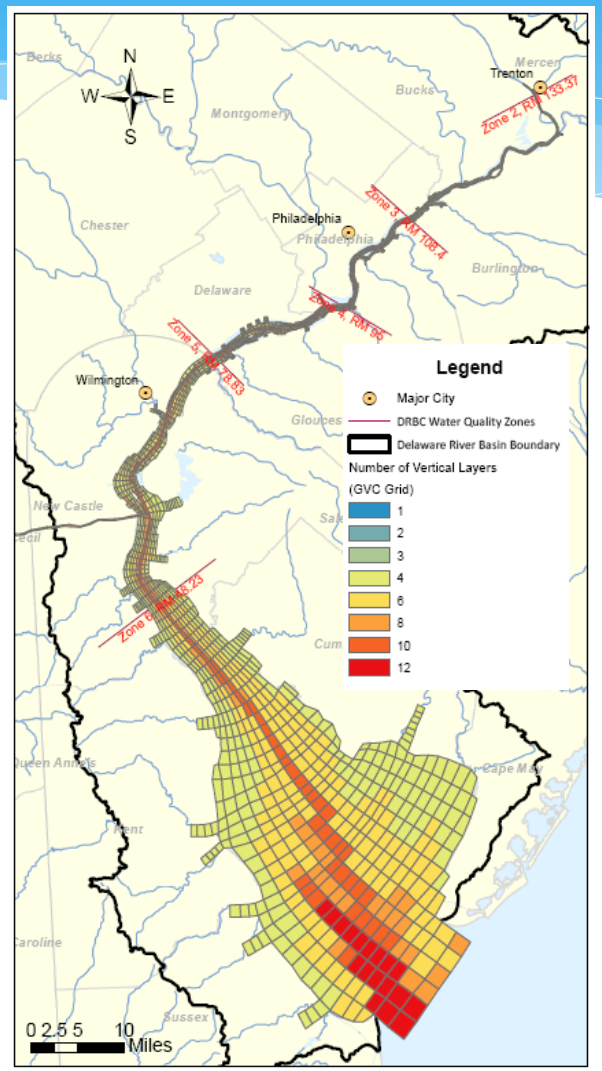
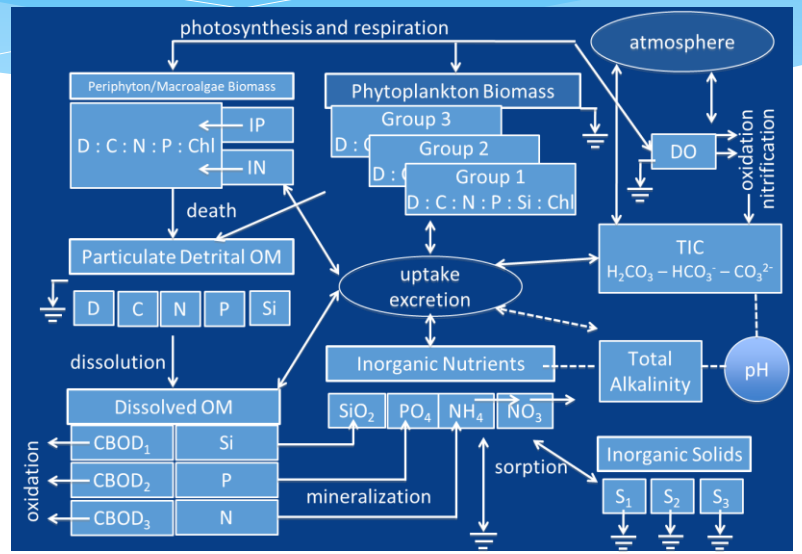
System-Wide Eutrophication Model

Hydrodynamic Model

- Provides transport information for WQ model
- Inflow boundaries for
  - 69 WWTPs
  - 37 tributaries
  - 76 stormwaters
  - 38 NPS runoffs
- 3D application of EFDC
  - 1,876 horizonal grid cells
  - 10 vertical layers in navigation channel (11,490 total cells)



Water Quality Model



- Water Quality Analysis Simulation Program (WASP)
  - Linked to EFDC
  - ~35 hrs/year run time for 3D
  - ~2 hrs/year run time for 2D

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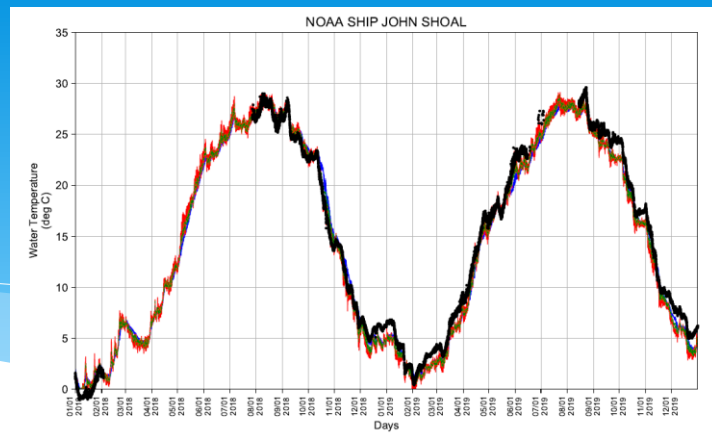
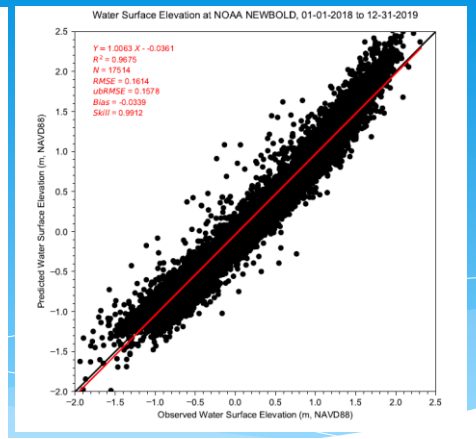
Hydrodynamic Model Calibration

- Calibration Periods
  - 2018, 2019
  - 2012 added to capture full range of hydrologic conditions
- Submodels developed to improve boundary conditions
  - Tributary temperature assignments
  - Flow at ungaged tributaries, watersheds, stormwater
- Calibration completed in 2020





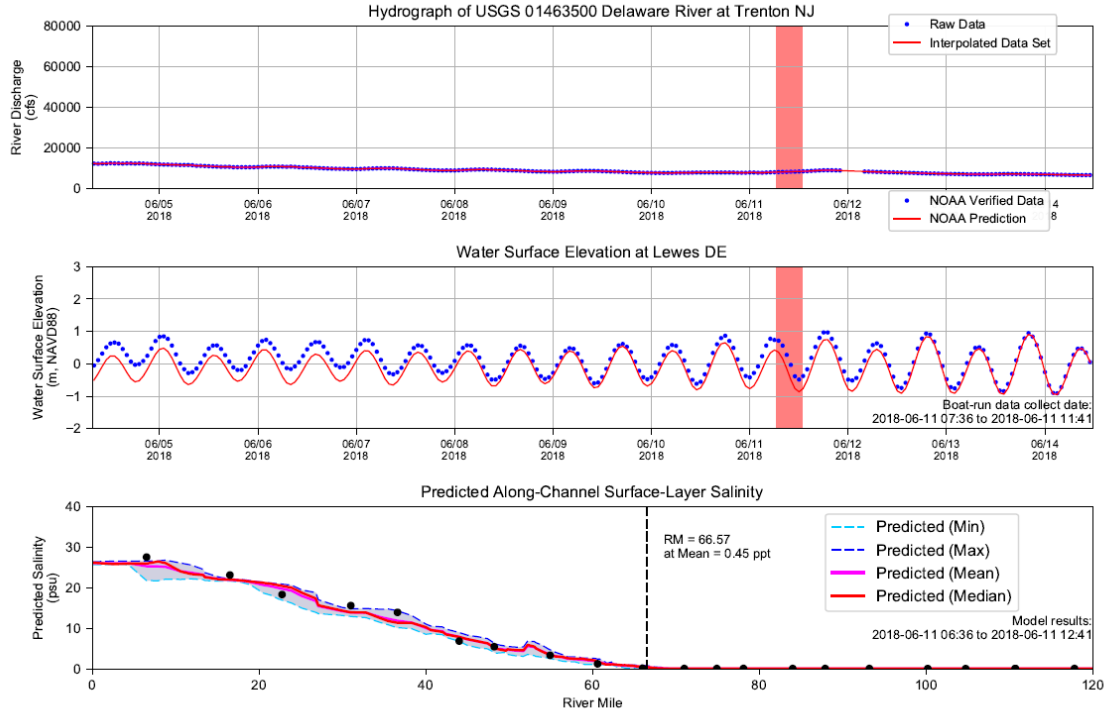


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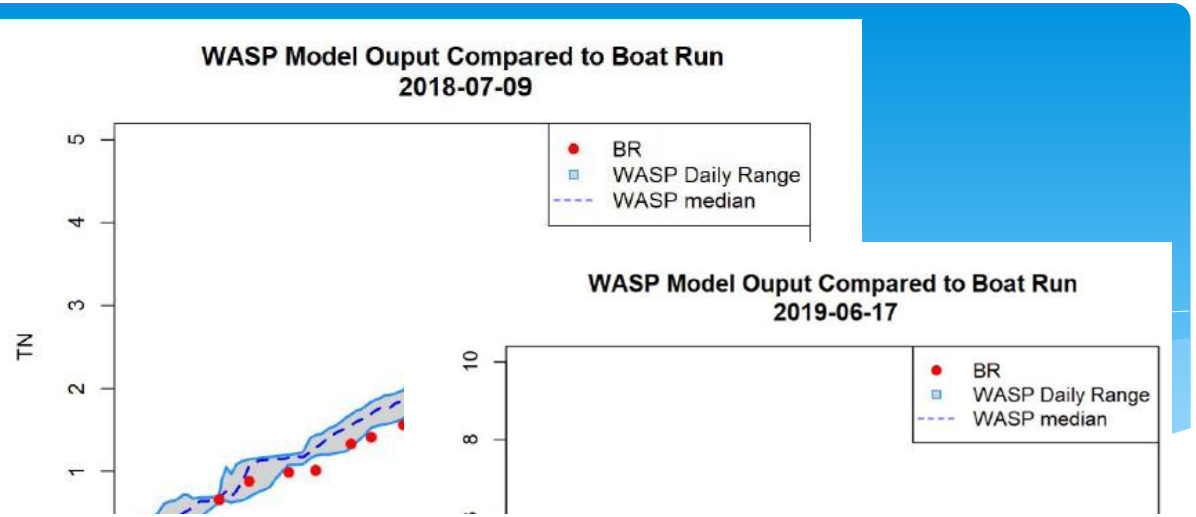
Figure --

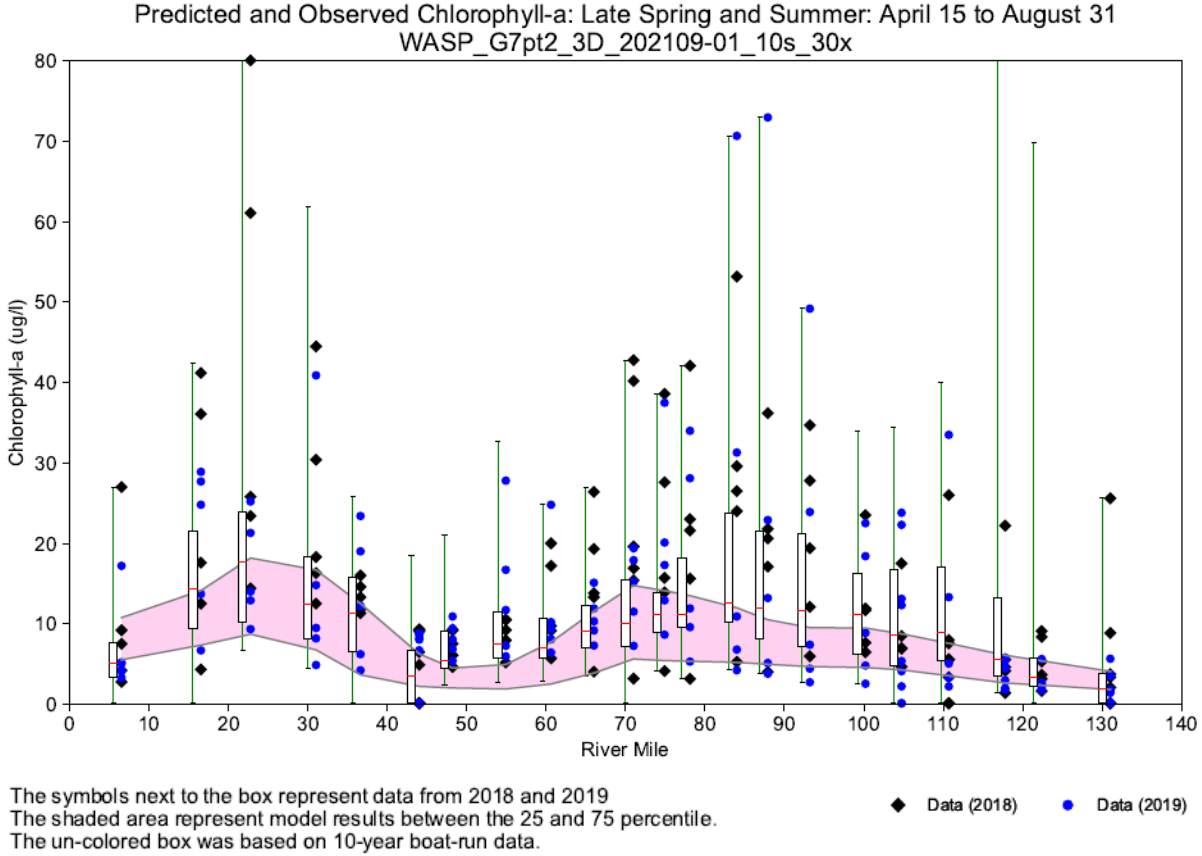
Longitudinal Profile of Salinityin Delaware River and Bay

Notes: Salinity and Chloride data collected by boat-run survey were used. Date that under detention limit were set to half of the detection limit.
Red shaded area indicates the boat run survey time period: 2018-06-11 07:36 to 2018-06-11 11:41
Model results along the navigation channel during period of 2018-06-11 06:36 to 2018-06-11 12:41 were used in this analysis.

Water Quality Model Calibration

- Significant advancements to state-of-the-art
  - EFDC-WASP Model Integration
    - Scale and complexity exposed limitations and inefficiencies
  - Statistical submodel for boundary assignments
    - Based on a regional analysis of shared features
    - Estimates flow and WQ at tributaries and watershed boundaries
  - Light extinction function re-formulated
    - Empirical Ke model f(RM, salinity, DOC, chl-a)
  - Reaeration formulation improvement
    - Mechanistic submodel incorporated
- Calibration to be completed in 2021

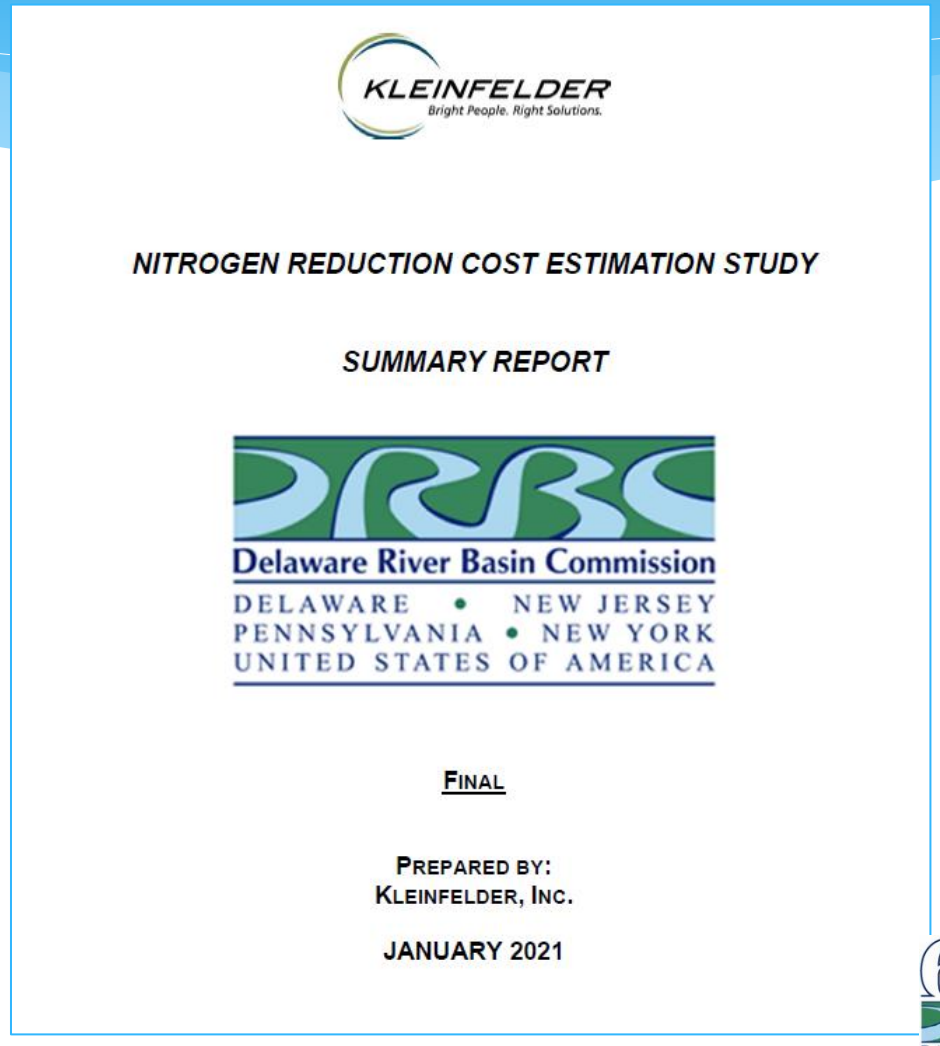




Cost and Feasibility Study

- Contracted with Kleinfelder
- Planning level cost estimate curve for top 12 loading facilities to achieve various ammonia effluent levels (10 mg/L – 1.5 mg/L)
- The total 2019 Worth Cost would be $1.1 – $2.7 Billion
- Task completed in January 2021

https://www.nj.gov/drbc/library/documents/NitrogenReductionCostEstimates_KleinfelderJan2021.pdf


KLEINFELDER
Bright People. Right Solutions.

NITROGEN REDUCTION COST ESTIMATION STUDY

SUMMARY REPORT

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FINAL

PREPARED BY:
KLEINFELDER, INC.

JANUARY 2021

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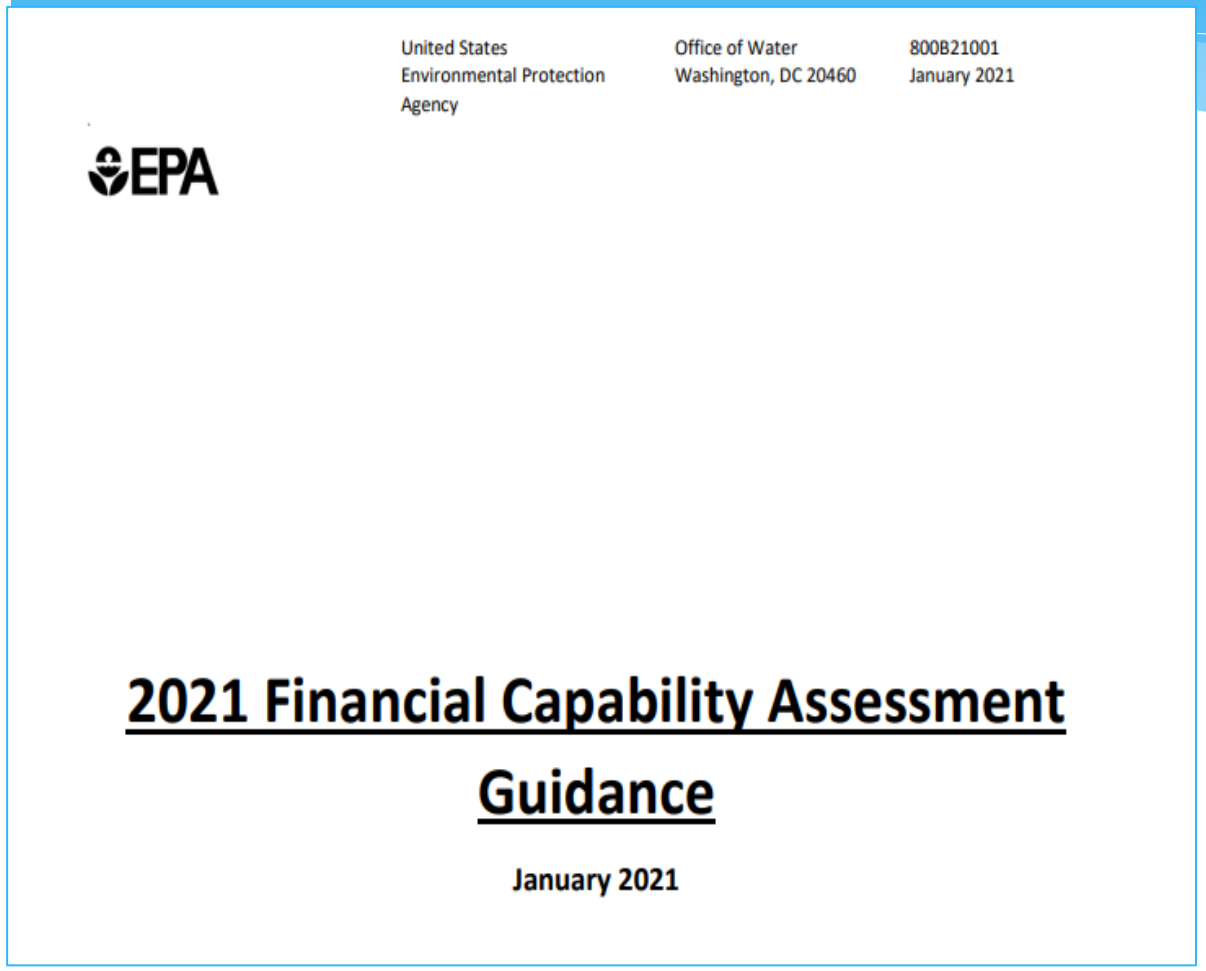
Socio Economic Evaluation

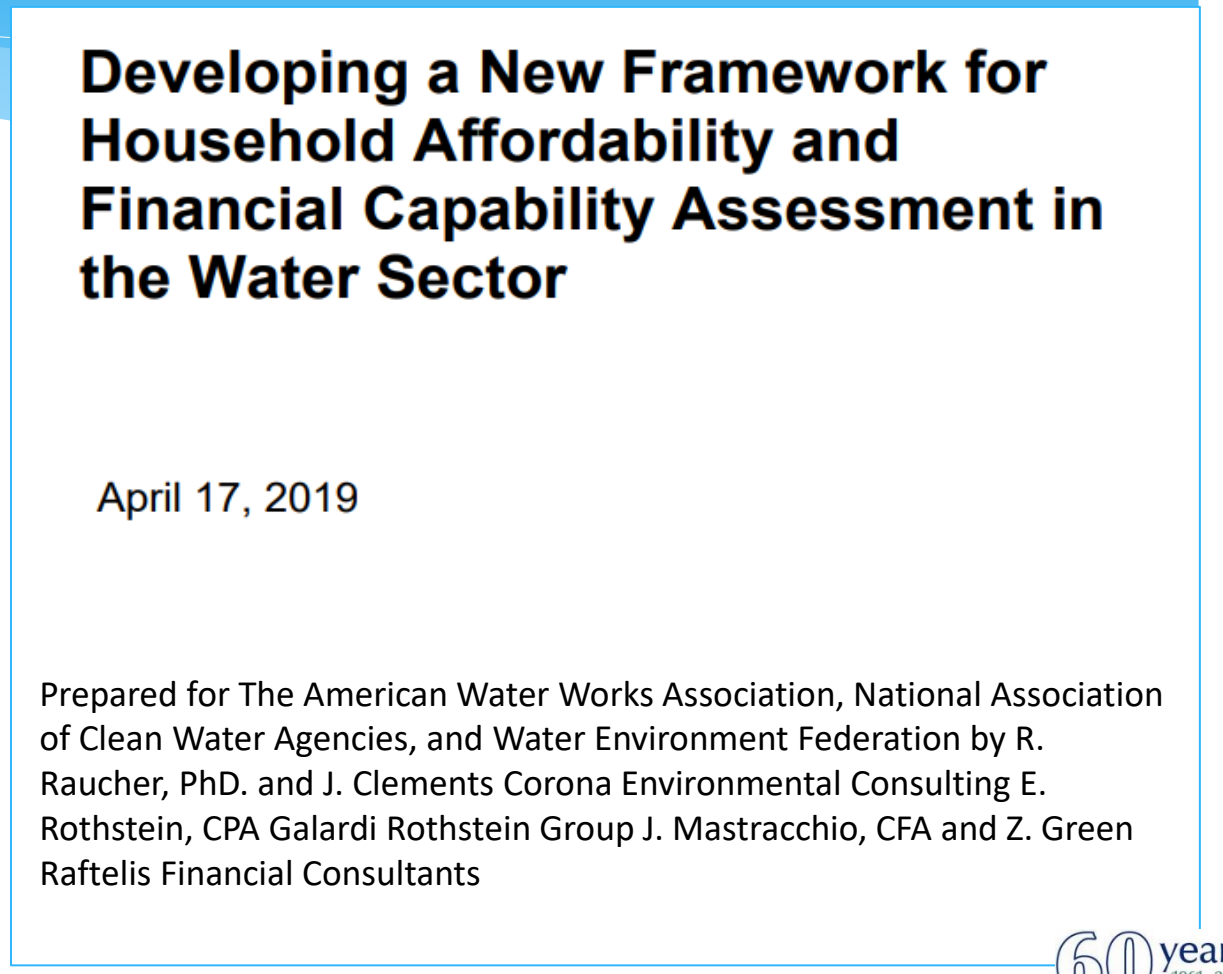


United States Environmental Protection Agency | Office of Water Washington, DC 20460 | 800B21001 January 2021

EPA

2021 Financial Capability Assessment Guidance

January 2021



Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector

April 17, 2019

Prepared for The American Water Works Association, National Association of Clean Water Agencies, and Water Environment Federation by R. Raucher, PhD. and J. Clements Corona Environmental Consulting E. Rothstein, CPA Galardi Rothstein Group J. Mastracchio, CFA and Z. Green Raftelis Financial Consultants

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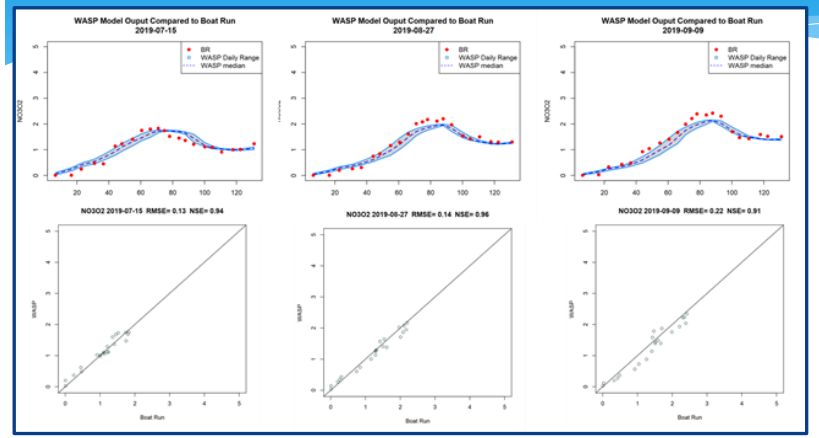
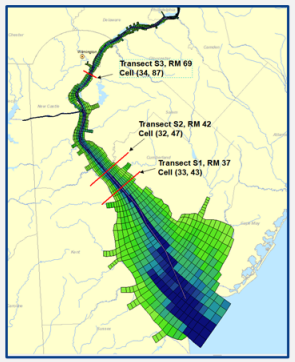
Elements of "Attainability Analysis"

Eutrophication Model Calibration



Design Condition / Future Scenarios

Eutro Model



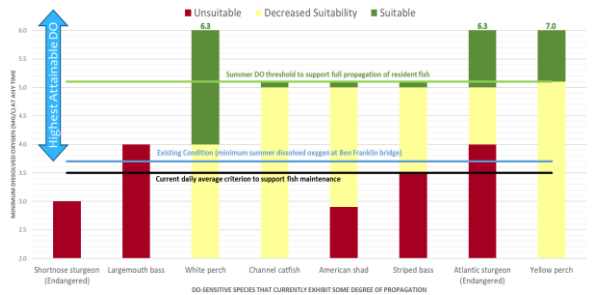
Refined Candidate Scenarios

? ? ? ?

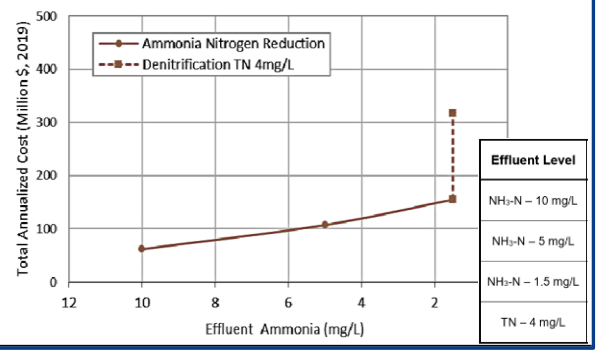
How much would DO condition improve if:

- Each of the point source nutrient scenarios were implemented
- Tributary boundaries were reduced
- Nonpoint sources were reduced
- Various sources reduced

Aquatic Life Protection Levels and DO



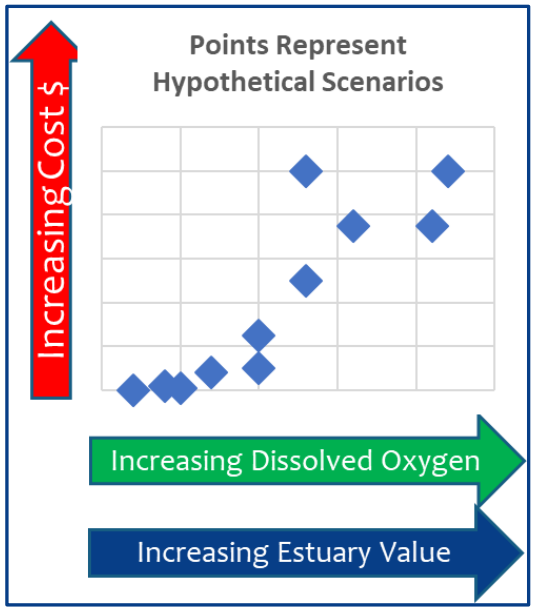
Treatability and Cost



Socio and Economic Evaluation

- Impact of enhanced fisheries on estuary value
- Evaluation of affordability
  - Implementation schedule
- Consideration of equity

Analysis of Attainability



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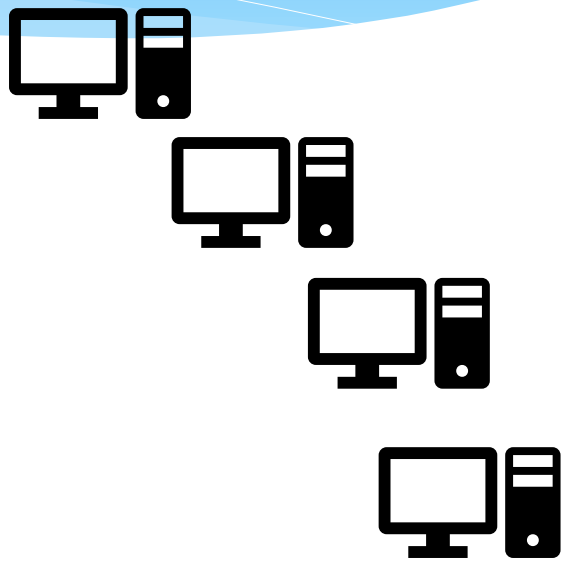
Lessons Learned and Next Steps

- Very different than Chesapeake Bay!
  - High energy system
  - More WWTP loads and less agriculture loads
- Drivers of low dissolved oxygen episodes:
  - Temperature and flow
  - CBOD, NBOD and Sediment oxygen demand (SOD)
  - Periods of low phytoplankton!
- Additional data needs exposed through study
  - Boundary phytoplankton matters! – more continuous monitoring at key locations
- How can we expect model to evolve in the future
  - Dynamic sediment model (sediment diagenesis model)
  - Exploration of future climatic scenarios



Summary

- DRBC front-loaded scientific and technical studies prior to rule making
- Aquatic life use is directly related to Dissolved Oxygen (in particular minimum DO)
- Linkages developed and being developed for
  - DO levels and fisheries response;
  - Levels of ammonia (and other nutrients) reductions and achievable DO levels;
  - Ammonia reduction technologies for WWTPs, cost and affordability
- Revised aquatic life designated use will be the enhanced degree of propagation associated with the highest attainable DO condition
- The draft 'Analysis of Attainability' is due by September 2022 then rule making

Acknowledgements

- Thomas Amidon, Manager, Water Resource Modeling
- John Yagecic, Manager of Water Quality Assessment
- Our modeling team: Li Zheng, Fanghui Chen, Vince DePaul (USGS), and Sarah Beganskas
- Our data science team, Jake Bransky and Elaine Panuccio.
- Model Expert Panels: Bob Chant (Rutgers Univ.), Carl Cerco, Steve Chapra (Tuffs Univ.), Tim Wool (EPA R4)
- Modeling consultant: Vic Bierman and Scott Hinz (LimnoTech)
- Water Quality Advisory Committee

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Managing, Protecting and Improving Our Shared Water Resources since 1961