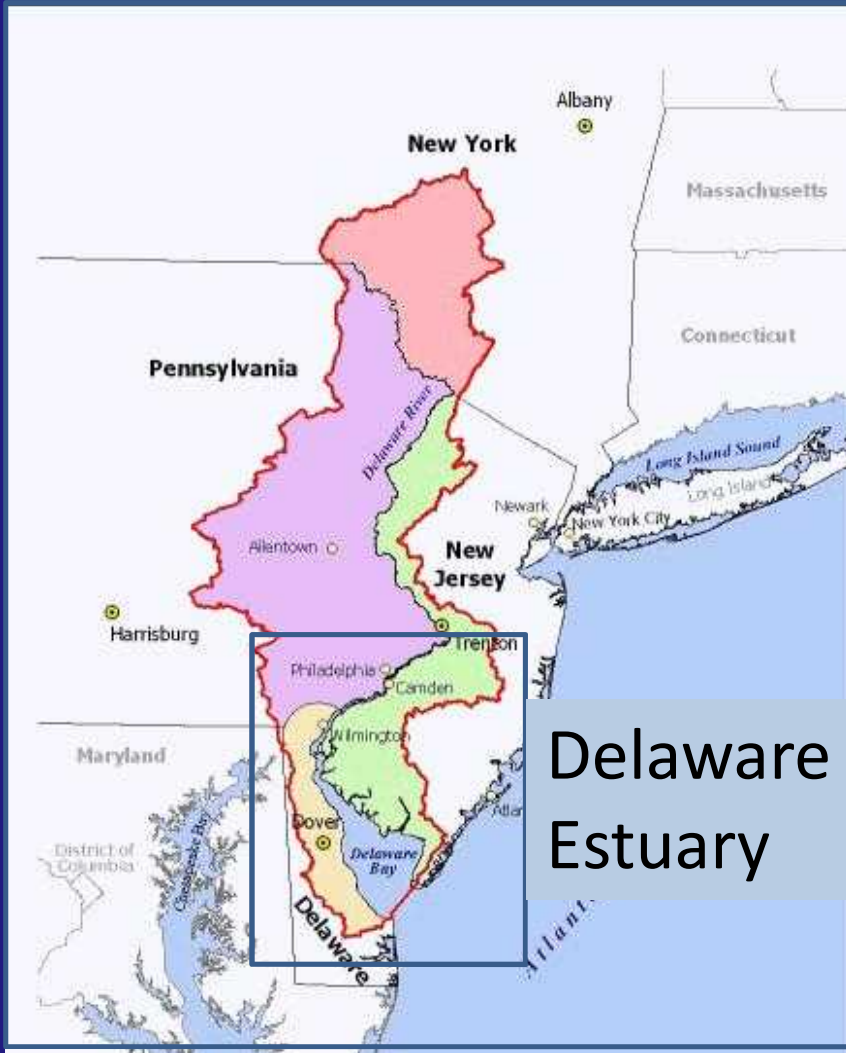# Nutrient and Dissolved Oxygen Monitoring for the Delaware Basin Demonstration Project
2008 - 2011

National Monitoring Network for Coastal Waters

Jeff Fischer and Eric Vowinkel
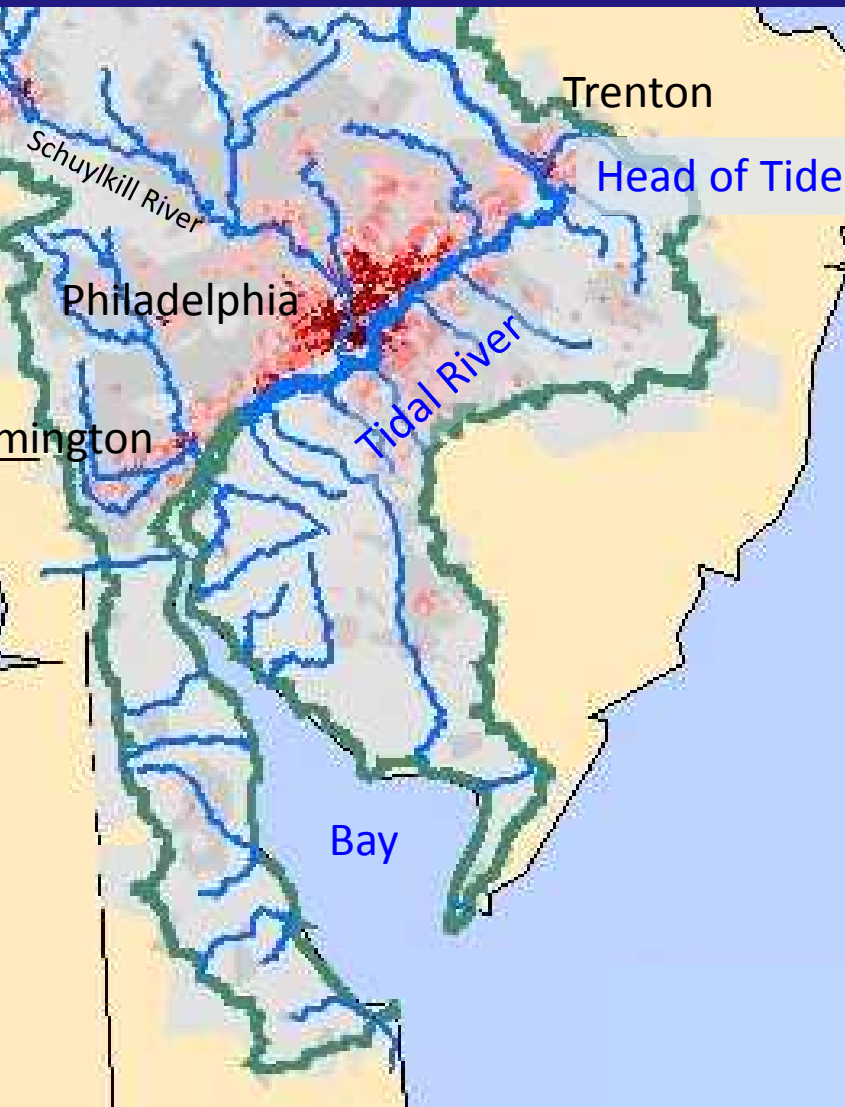
Delaware Basin

Delaware Estuary

- Basin is over 12,600 square miles and includes parts of four States.

- Population is approaching 8 million, most of whom live around the estuary.

- Delaware River Basin Commission (DRBC)

Delaware Estuary

Highly Urbanized sea port

- ## Upper Tidal River
  - Fresh water -- Trenton to Philadelphia
  - Drinking Water Supply
  - Sewage Discharges

- ## Lower Tidal River
  - Mixing Zone Philadelphia to South of Wilmington

- ## Bay
  - Shallow – much < 10 meters

Water Quality Issues

- Drinking Water
- Sewage Discharges
- Nutrients
- Low Dissolved Oxygen
- Declines in fish & shellfish populations
- PCB contamination
- Maintaining Ports
- etc...

NMN Chosen Areas of Study

Dissolved Oxygen (DO) and Nutrients

- Total nitrate concentration in estuary typically 2 mg/L as N.

- Low DO levels in the summer months violate established criteria and may be harmful to certain species of fish.

- Ammonia is a concern because it contributes to oxygen depletion, and may itself be harmful to some species of fish.

Sediments

Historical DO Trends 1965 to present

Summer Dissolved Oxygen near Philadelphia
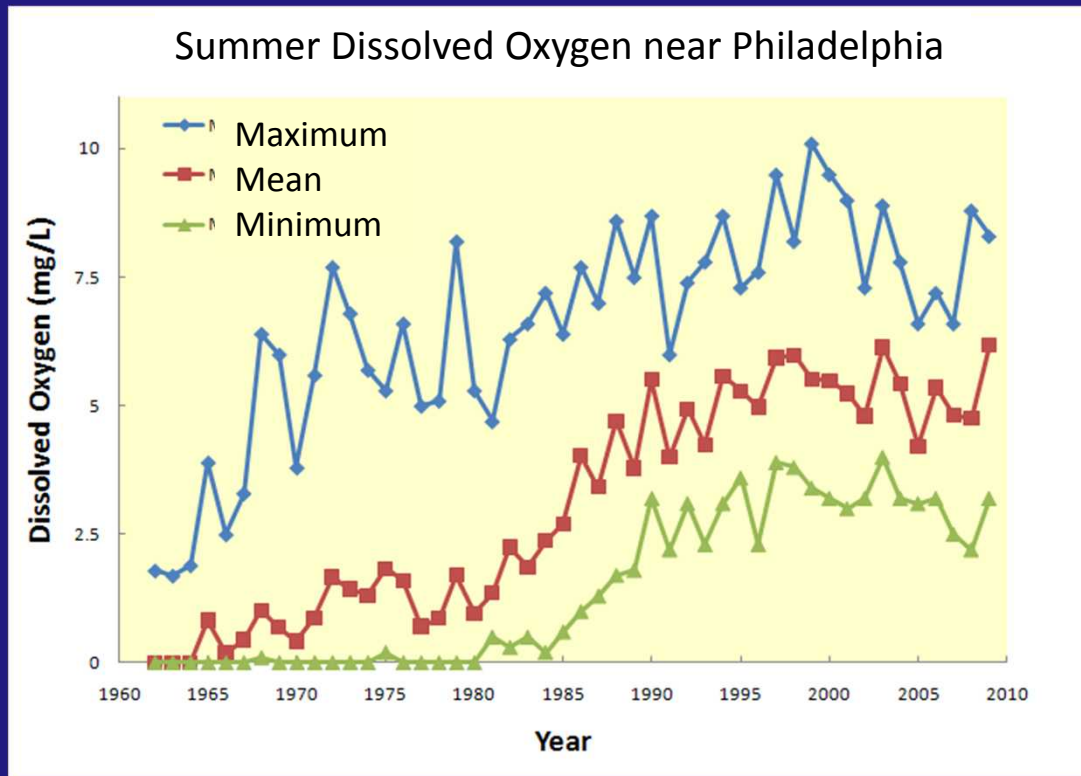
DO has improved in the Philadelphia region of estuary from 1960s through 1980s.

- Clean Water Act
- Phosphate Ban
- Less Industrial Waste
- Reservoir releases maintain summer flows

DO is improved, but still a problem

Environmental PROTECTION

Estimated over 100,000 fish killed

Low Oxygen Cause of Menhaden Die-off in Delaware Bay

Aug 13, 2010

The New Jersey Department of Environmental Protection (DEP) on Aug. 12 received new water sampling results that strongly suggest low oxygen levels were behind the massive die-off of menhaden in Delaware Bay.

Three of four samples taken showed dissolved oxygen levels below 5 micrograms per liter. Any level below that is considered biologically stressed. The fourth sample was just above the threshold. The lowest reading - 3.4 micrograms per liter - was recorded at Pierce's Point in Middle Township, one of the areas hard hit by washed-up fish.

"Although taken after the fact, these tests suggest that oxygen levels in the bay were probably very low and caused the die-off of fish," said Robert Van Fossen, the DEP's assistant director for Emergency Management. "These low levels likely occurred as a result of very warm weather and warm temperatures in the bay. The warmer water is the less dissolved oxygen it is able to hold. If the fish schooled very tightly in shallows very close to shore for any reason, they may have simply used up all the oxygen that was available

Nitrate Loads as N (MKg/Yr)

Delaware R. ~ 11

Schuylkill R. ~ 13

Christina R. ~ 3

Delaware Bay

- Total Estuary Nitrate Load ~ 44 MKg/Yr
  - (12 % ATM, 28% Ag, 47% Pt Source, 14% Dev.)

- Direct Point Source Discharges to Estuary ~ 16 MKg/Yr

- Ammonia is a large component of estuary discharges

Load Estimates From SPARROW model

Knowledge Gaps

- Ammonia and other nitrate species not being monitored in the estuary on a routine basis (only total nitrogen).

- In the upper estuary DO was not being continuously monitored.

- Importance of diurnal variations?

- Lack of understanding of interactions between DO, ammonia, other nutrients, carbon, silica, algal growth, bay hydrodynamics, and sediment dynamics (turbidity)

http://acwi.gov/monitoring/network/pilots/dlrbay/

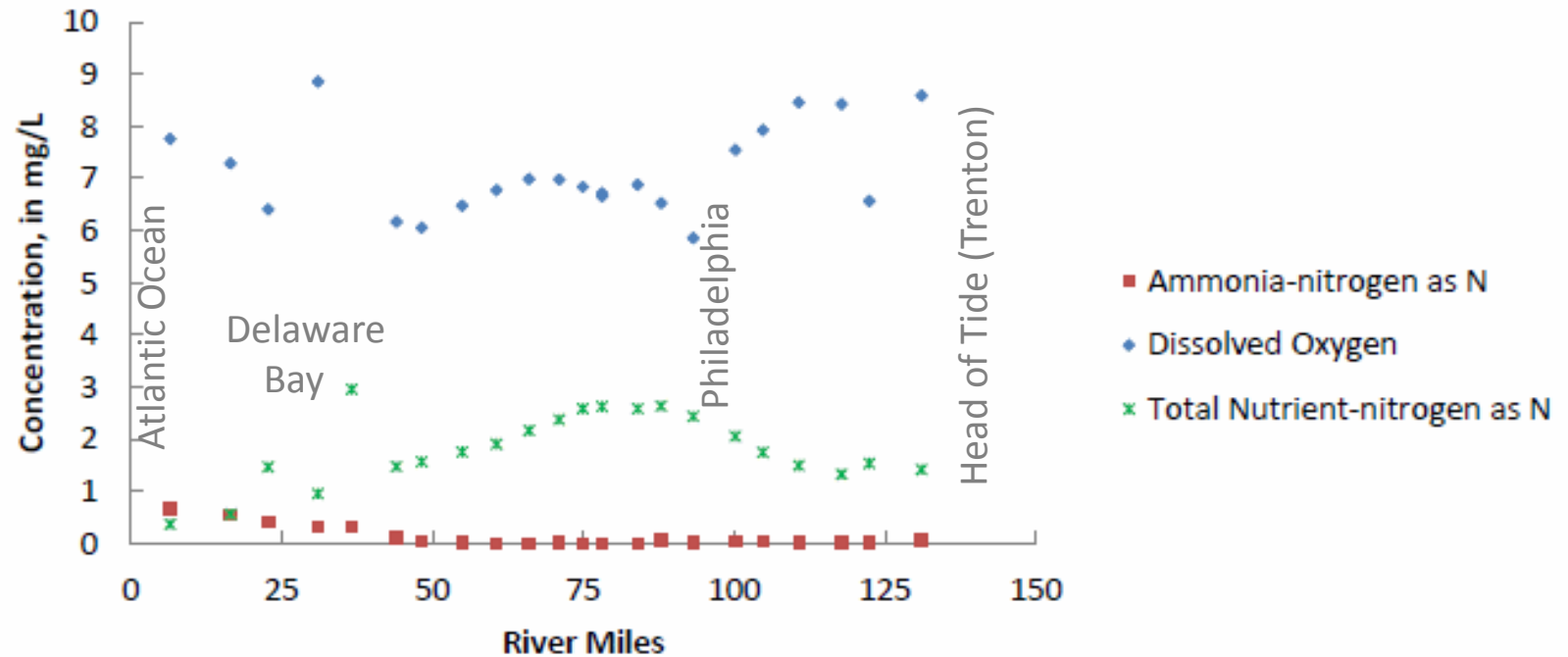# Building a Collaborative Network Improved Nutrient Monitoring
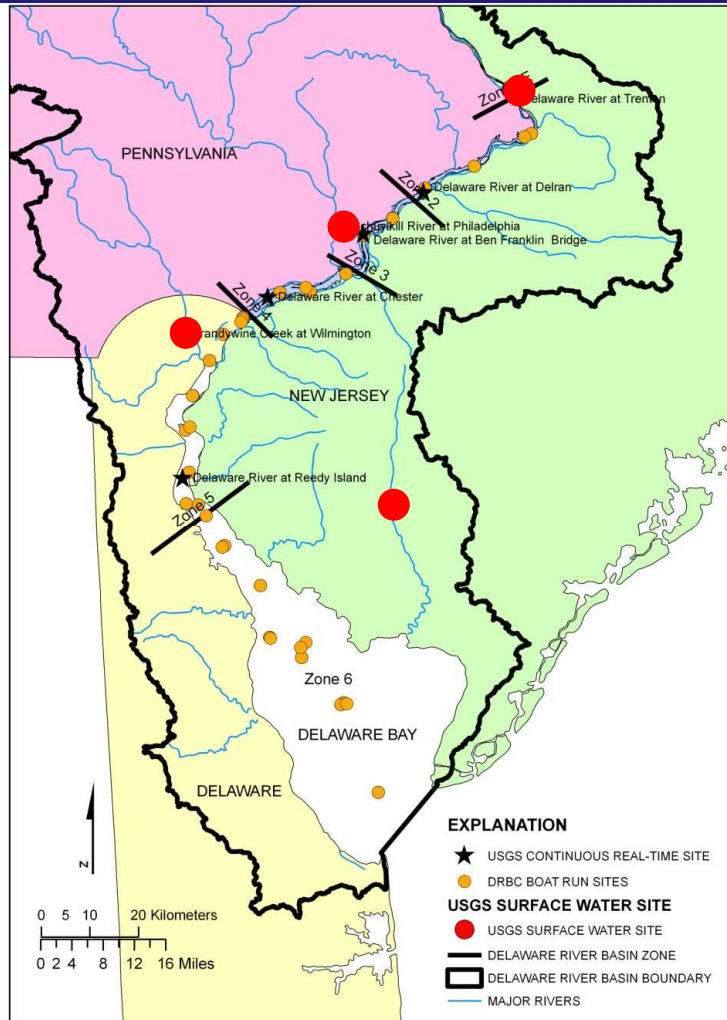
- Sampling for a wider range of nutrient species at four existing tributary locations that account for over 90 percent of the flow to the estuary. Sediment too.

- Added ammonia and other nutrient species analyses at 22 existing DRBC Boat-run locations. Sites are sampled 8 times per year.
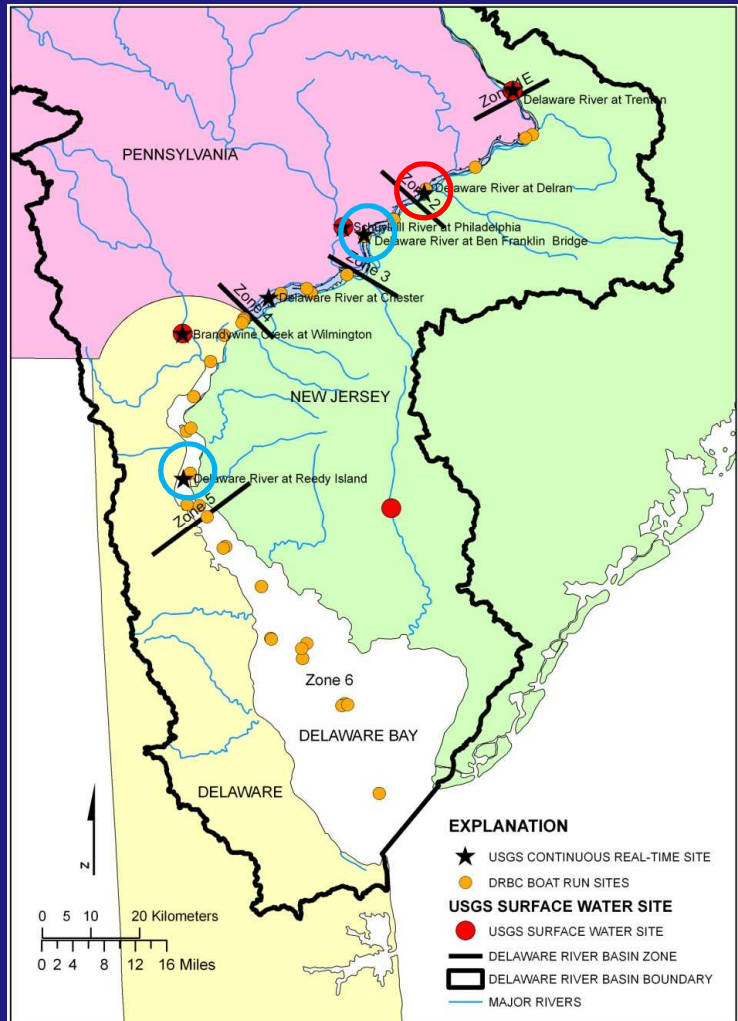
Filling Gaps - Boat Run Data

Trenton   Philadelphia   Bay
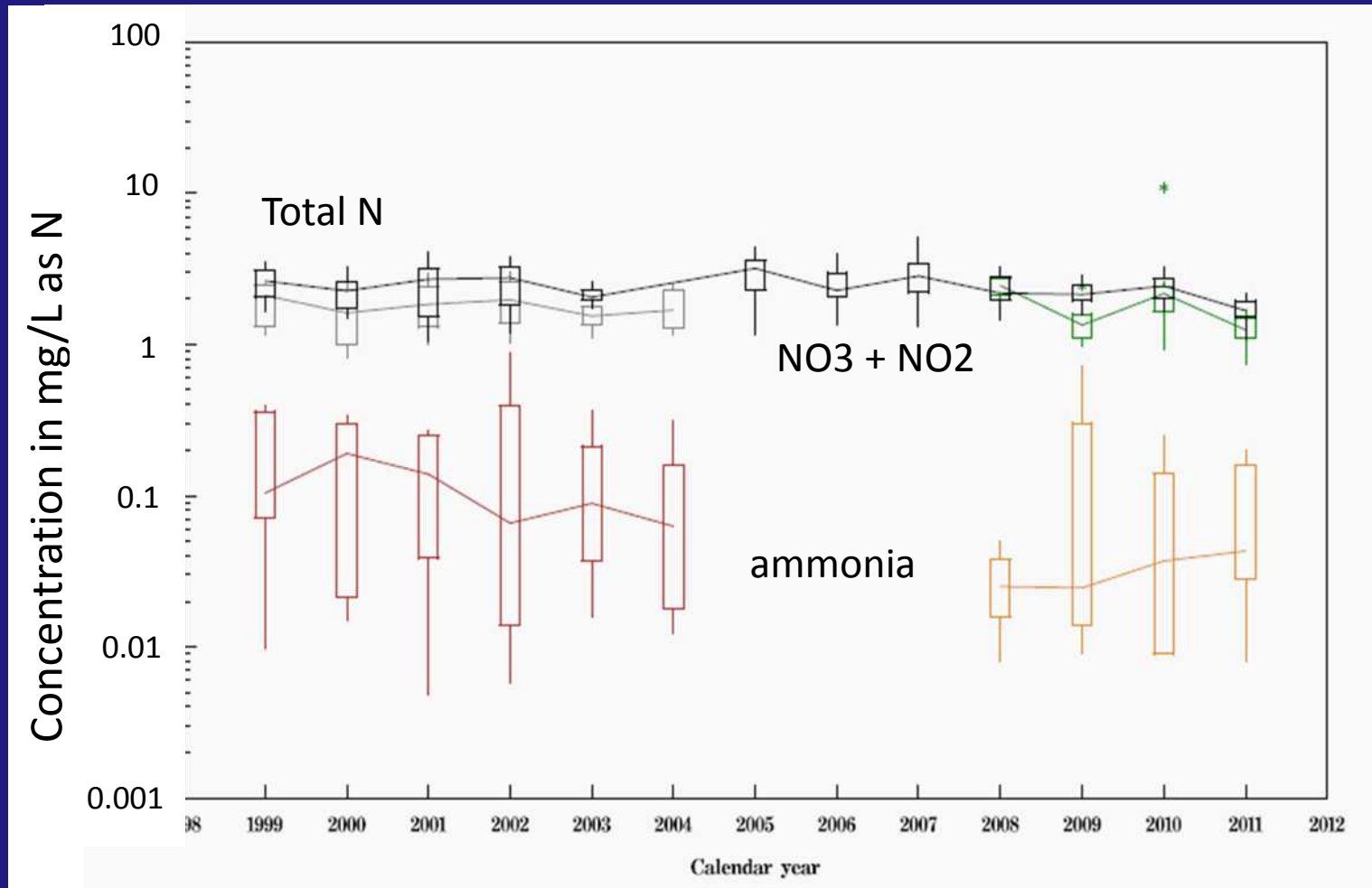
DO and Nutrient Profile in Estuary

Delaware River Boat Run Data
June 22, 2010

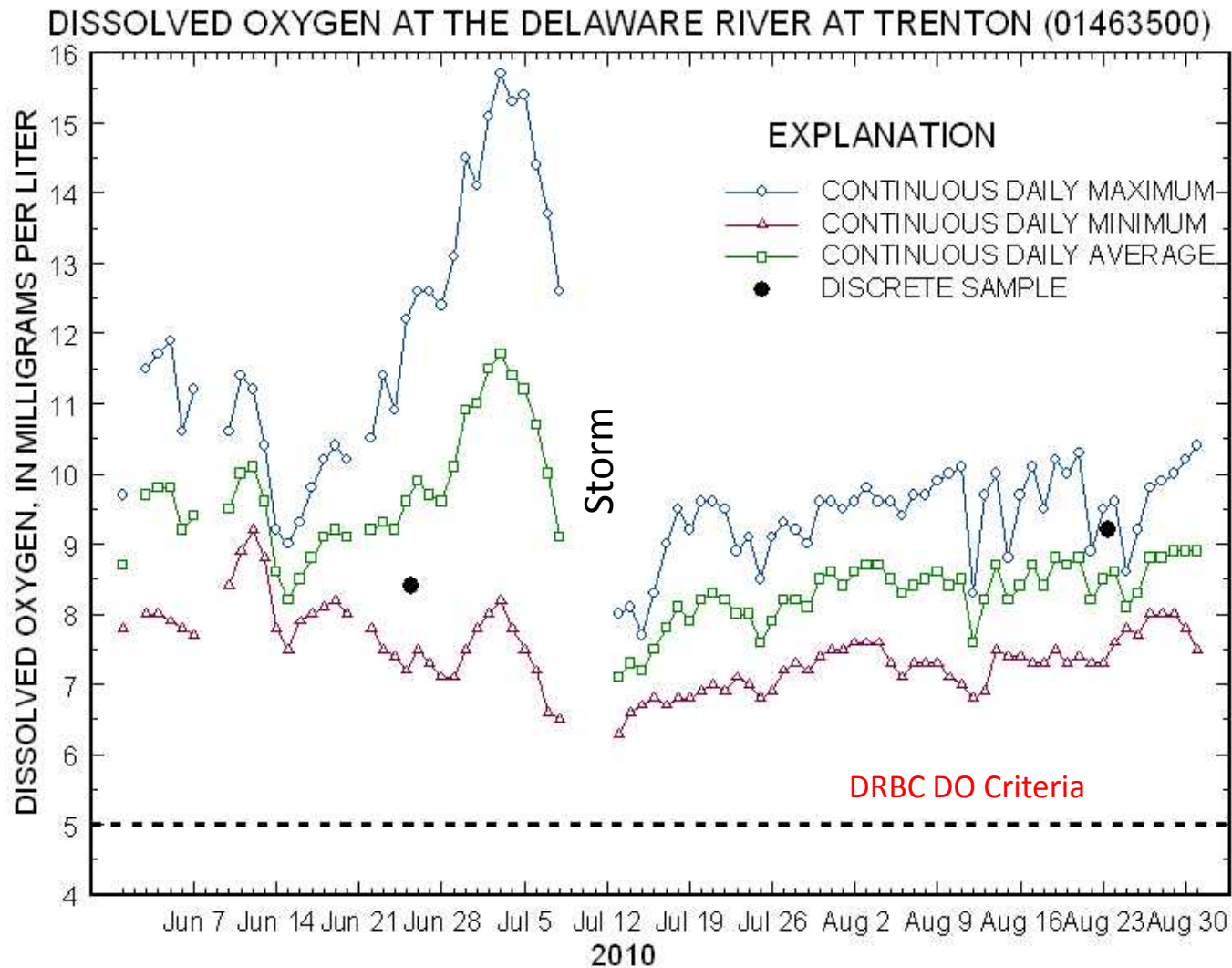# Building a Collaborative Network
Real-Time Monitors

○ Added real-time DO, SC, pH, temperature, and turbidity monitor in upper estuary.

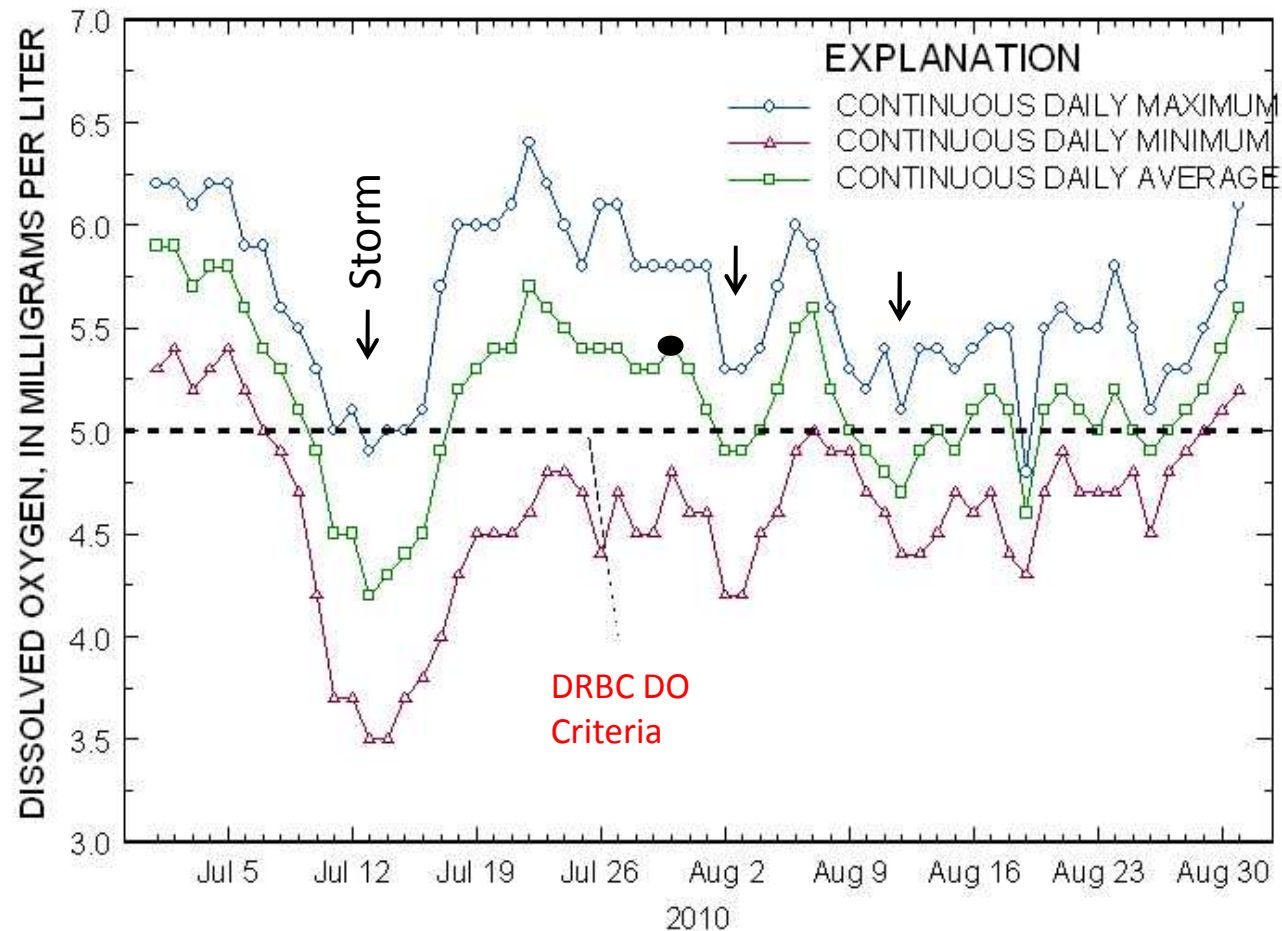○ Added turbidity to existing monitors at three locations.

Results analyzed real-time and electronic notifications sent out for exceedences.

Real-Time Monitors Show Full Range of Data

DISSOLVED OXYGEN AT THE DELAWARE RIVER AT TRENTON (01463500)

EXPLANATION

- —○— CONTINUOUS DAILY MAXIMUM
- —△— CONTINUOUS DAILY MINIMUM
- —□— CONTINUOUS DAILY AVERAGE
- ● DISCRETE SAMPLE

DRBC DO Criteria

Storm

DISSOLVED OXYGEN, IN MILLIGRAMS PER LITER

Jun 7 Jun 14 Jun 21 Jun 28 Jul 5 Jul 12 Jul 19 Jul 26 Aug 2 Aug 9 Aug 16 Aug 23 Aug 30
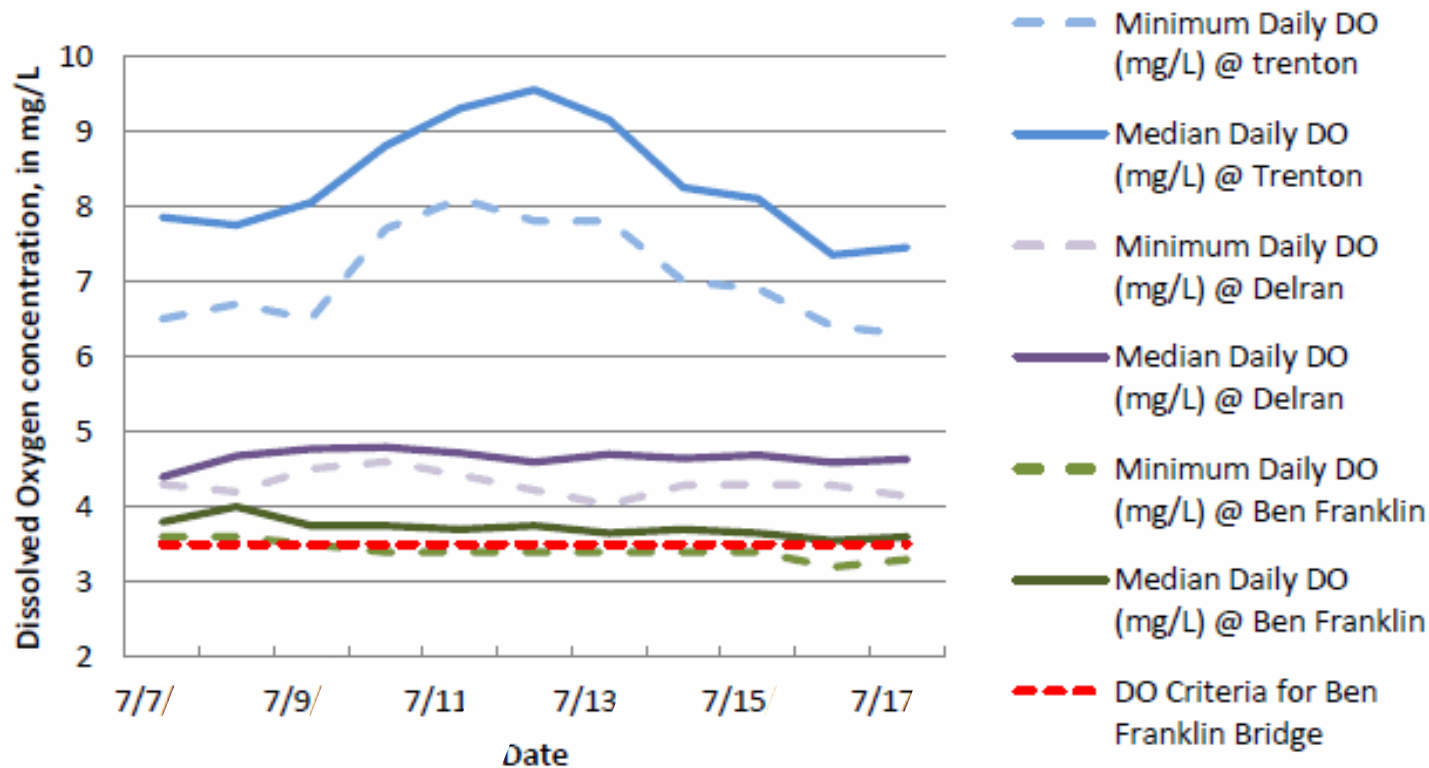
2010

NMN Monitor at Delran

DISSOLVED OXYGEN AT THE DELAWARE RIVER AT DELRAN (01467029)

Change in DO between Trenton and Philadelphia

Daily Minimum and Median Dissolved Oxygen at Three Delaware River Continuous Water Quality Monitors

Analysis Leading to Decisions

- Based on existing DO and nutrient data, including NMN data, DRBC has passed regulations that require point-source dischargers to monitor for nutrient species.

- Tributary data can be used to calculate nutrient loads to the estuary. (synergy with SPARROW model)

- Nutrient and real-time data will be used in estuary hydrodynamic and water quality models to better understand oxygen depletion, and other water quality conditions in the tidal river and bay.

- Ultimately nutrient loads to the estuary will be controlled to reduce oxygen sag and algal growth.

Key Partners

Federal

- U.S. Geological Survey
- National Oceanic and Atmospheric Administration
- U.S. Environmental Protection Agency
- U.S. Army Corp of Engineers

State

- Delaware Department of Natural Resources and Environmental Control
- New Jersey Department of Environmental Protection
- Pennsylvania Department of Environmental Protection

Others

- Delaware River Basin Commission
- University of Delaware
- Rutgers University
- MACOORA
- Partnership for the Delaware Estuary
- New Jersey Water Monitoring Coordination Council
- Philadelphia Water Department
- National Science Foundation

Continued Monitoring and Analysis

- Continue and expand real time monitoring
  - Real-time monitoring continuing
  - Added real-time monitor on ferry at mouth of bay
  - Remotely operated vehicles in Delaware Bay
- Continue tributary and STP monitoring
- Data analysis – Hourly, Daily, Seasonally, Yearly, Decadal
  - Technical Report (in press) http://www.delawareestuary.org
- Future development of hydrodynamic and water quality models.
  - Ammonia, DO, & turbidity are crucial constraints
- Delaware River Sediment Management Plan

SUMMARY

Enhanced tributary, estuary, and real-time monitoring networks.

Building Partnerships to coordinate and enhance data collection and analysis.

Strong Support from DRBC and MACOORA

Data being used to make decisions.

More information at:
http://nj.usgs.gov/projects/24549U20A/natmonitornet/

Jeff Fischer – fischer@usgs.gov

Questions?