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

National Monitoring Network for Coastal Waters

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Delaware Basin

- 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

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

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)

- 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

Concentration in mg/L as N

Total N
NO3 + NO2
ammonia
DO and Nutrient Profile in Estuary

Delaware River Boat Run Data
June 22, 2010

- Concentration, in mg/L
- River Miles

- Atlantic Ocean
- Delaware Bay
- Philadelphia
- Head of Tide (Trenton)

- Ammonia-nitrogen as N
- Dissolved Oxygen
- Total Nutrient-nitrogen as N
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

**EXPLANATION**

- Continuous Daily Maximum
- Continuous Daily Minimum
- Continuous Daily Average
- Discrete Sample

**Dissolved Oxygen at the Delaware River at Trenton (01463500)**

- **Storm**
- **DRBC DO Criteria**

**Graph Details:**
- Y-axis: Dissolved Oxygen, in milligrams per liter
- X-axis: Dates from June 7 to August 30, 2010
NMN Monitor at Delran

Dissolved Oxygen at the Delaware River at Delran (01467029)

EXPLANATION
- Continuous Daily Maximum
- Continuous Daily Minimum
- Continuous Daily Average

Storm

DRBC DO Criteria
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
• 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/

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Questions?