

Delaware River Basin Commission

Managing Delaware River Basin Water Resources with Monitoring and Data

NJ Water Environment Association

103 Annual Conference & Exposition

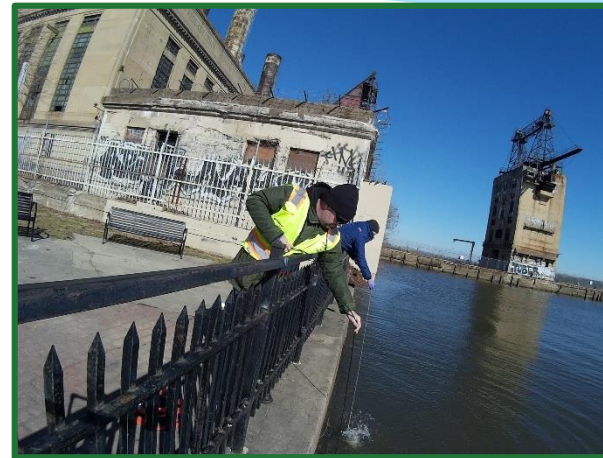
Bally's, Atlantic City, NJ

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Manager, Water Quality Assessment

Namsoo Suk, Ph.D., Ron MacGillivray, Ph.D.,

Elaine Panuccio



Delaware River Basin Commission

DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Delaware River Basin Commission

Compact signed 1961

Five Equal Members:

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

Broad Responsibilities / Authorities

- Water Supply
- Drought Management
- Flood Loss Reduction
- Water Quality
- Watershed Planning
- Regulatory Review (Permitting)
- Outreach/Education
- Recreation

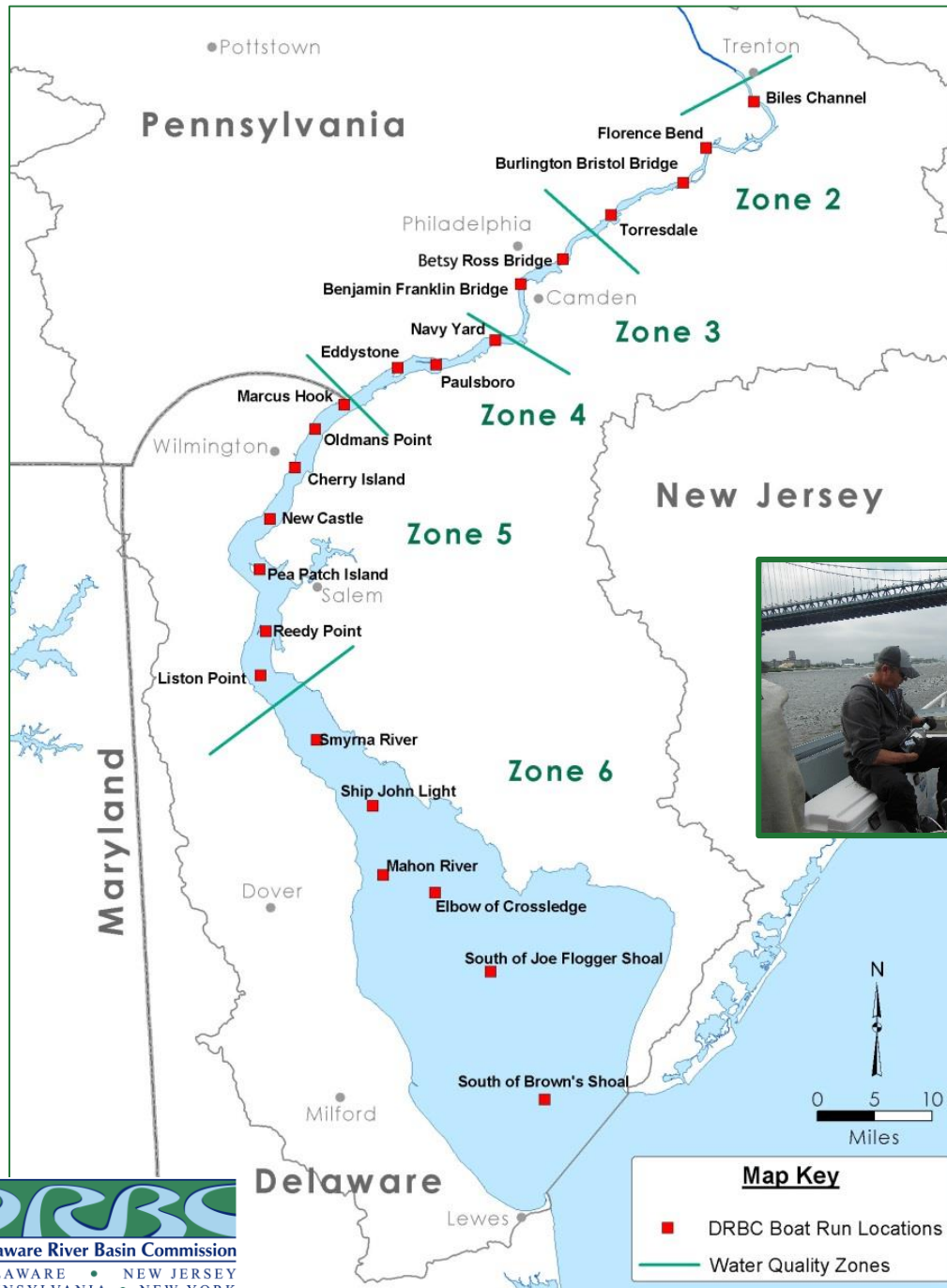


Goal of this Presentation

- * Describe Key DRBC Monitoring Programs & selected one-time projects
 - How we use the data
 - How we serve the data & interpretation to partners and stakeholders
- * Highlight and demonstrate some unique data treatments including
 - Interactive web applications
 - Automated dashboards
 - Automated modeling
 - Animated graphing
- * How we use data generated by others including USGS and NOAA



Delaware Estuary Water Quality Monitoring (Boat Run)



* Since mid-1960's

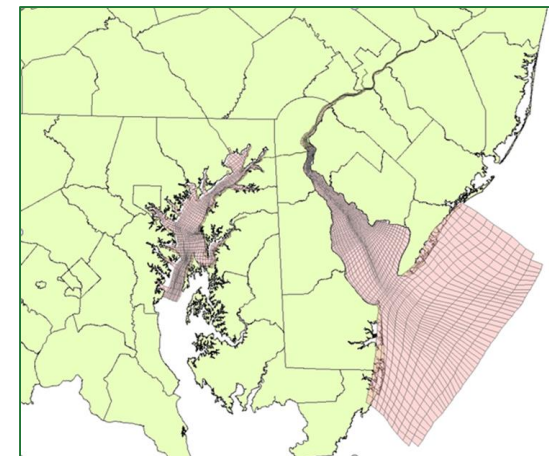
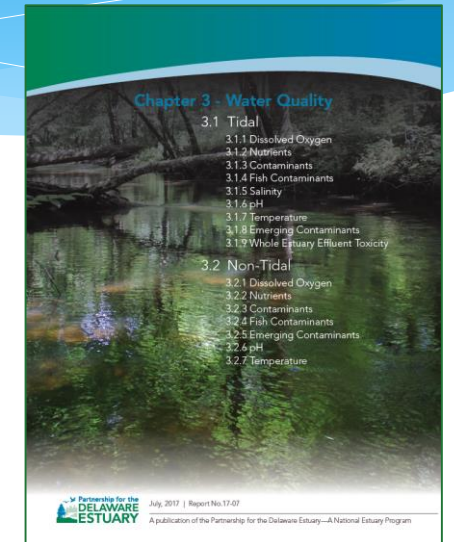
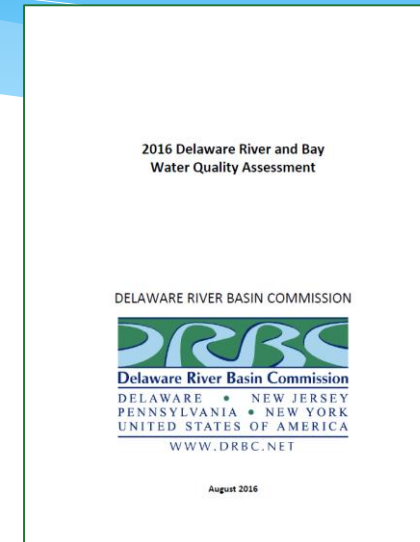
* 22 Sites, once per month

* Parameter Groups

- Dissolved Oxygen, pH, temperature, specific conductance, turbidity, secchi depth, PAR
- Nutrients (ammonia, nitrate + nitrite, phosphorus)
- Sodium, chloride, Chlorophyll a
- Bacteria
- Metals

How we use the Delaware Estuary water quality data

- * Delaware River & Bay Water Quality Assessment Report
 - CWA 305(b)
 - Every even numbered year
- * State of the Estuary Report
 - Cooperation with Partnership for the Delaware Estuary (PDE)
 - ~ Every 5 years
- * Estuary Eutrophication Model (under development)
- * Estuary Water Quality Explorer at <https://johnyagecic.shinyapps.io/BoatRunExplorer/>
- * Canned database queries on DRBC web site at <http://www.state.nj.us/drbc/quality/datum/>



DRBC Delaware Estuary Water Quality (Boat Run) Explorer

Select settings for Water Quality display

Choose a Water Quality variable to display

Turbidity (NTU)

Data Year Window



Display by

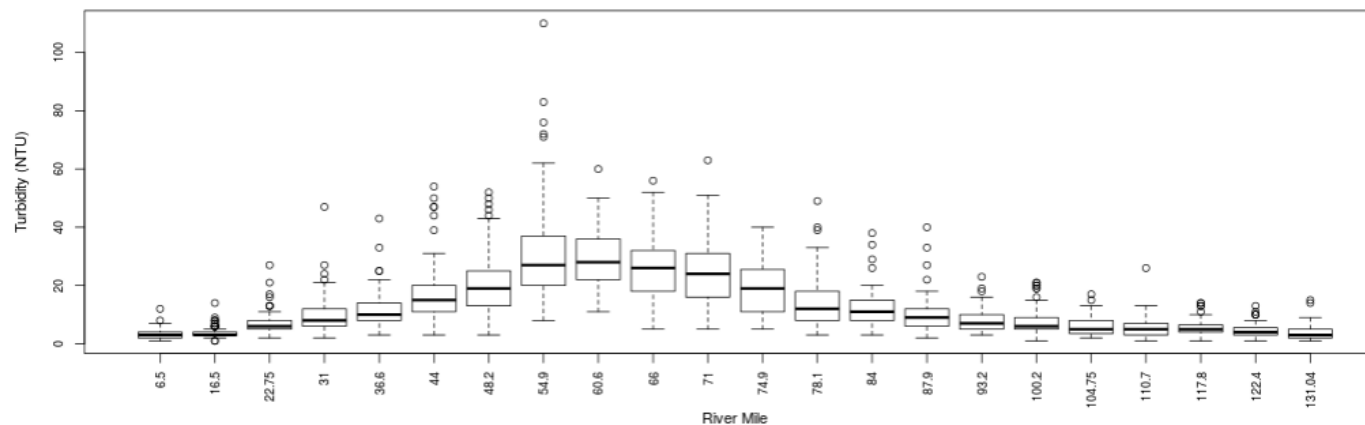
- River Mile
- Month



Turbidity (NTU)

2007 through 2016

River Mile Guide: Mouth of Delaware Bay at River Mile 0, Ben Franklin Bridge at River Mile 100, Trenton at River Mile 133



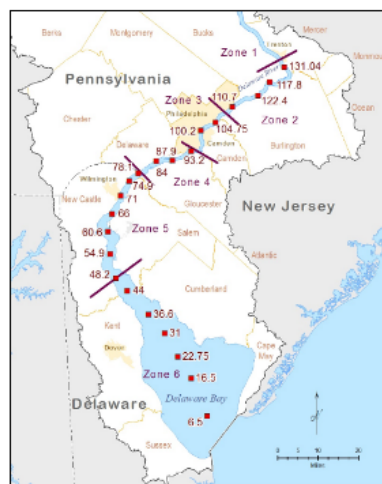
[Learn more about DRBC's Estuary Monitoring Program](#)

[What's a box plot?](#)

[Download the data](#)

[Guide to DRBC's River Mile System](#)

programmed by John Yagecic (John.Yagecic@drbc.nj.gov)

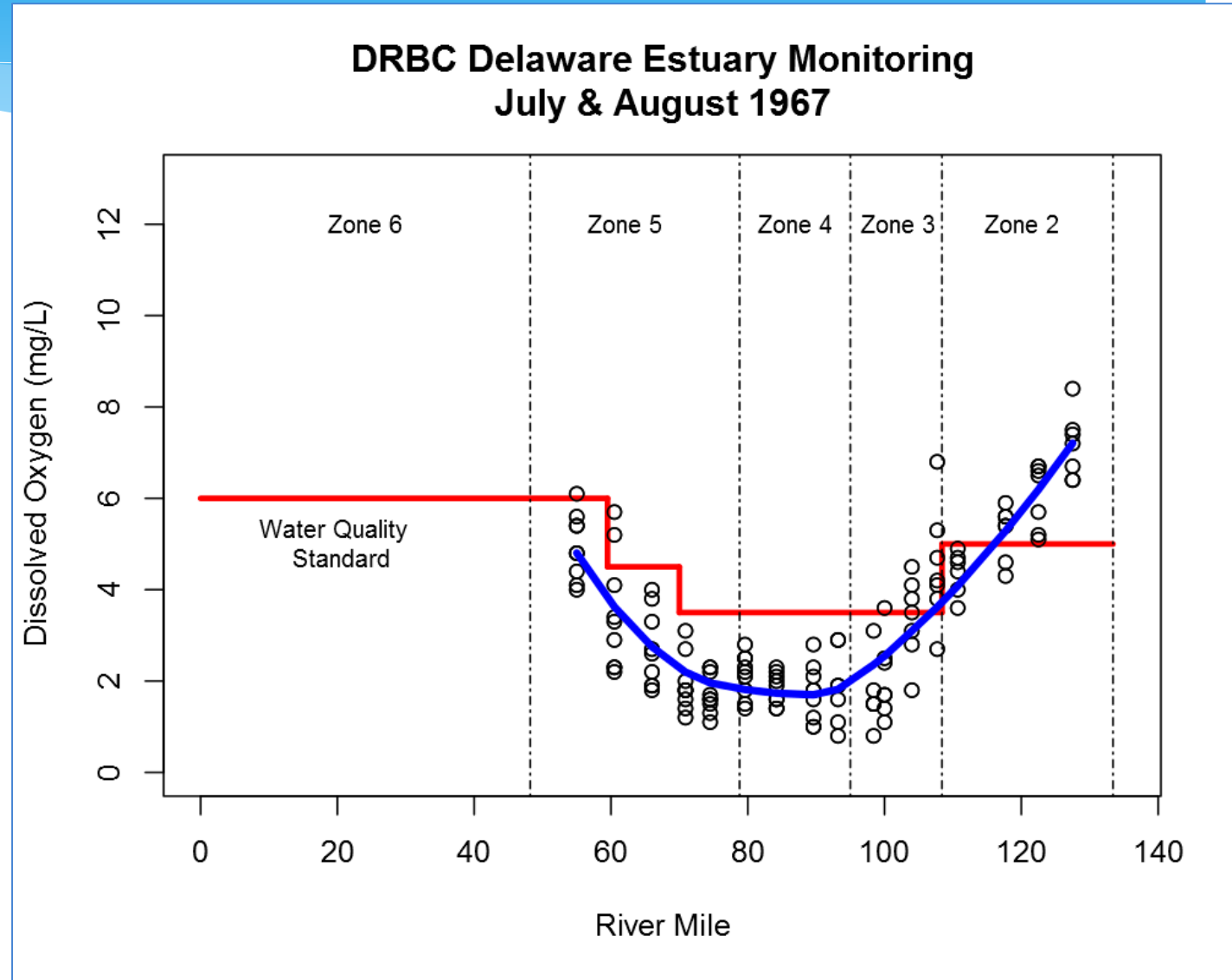


<https://johnyagecic.shinyapps.io/BoatRunExplorer/>

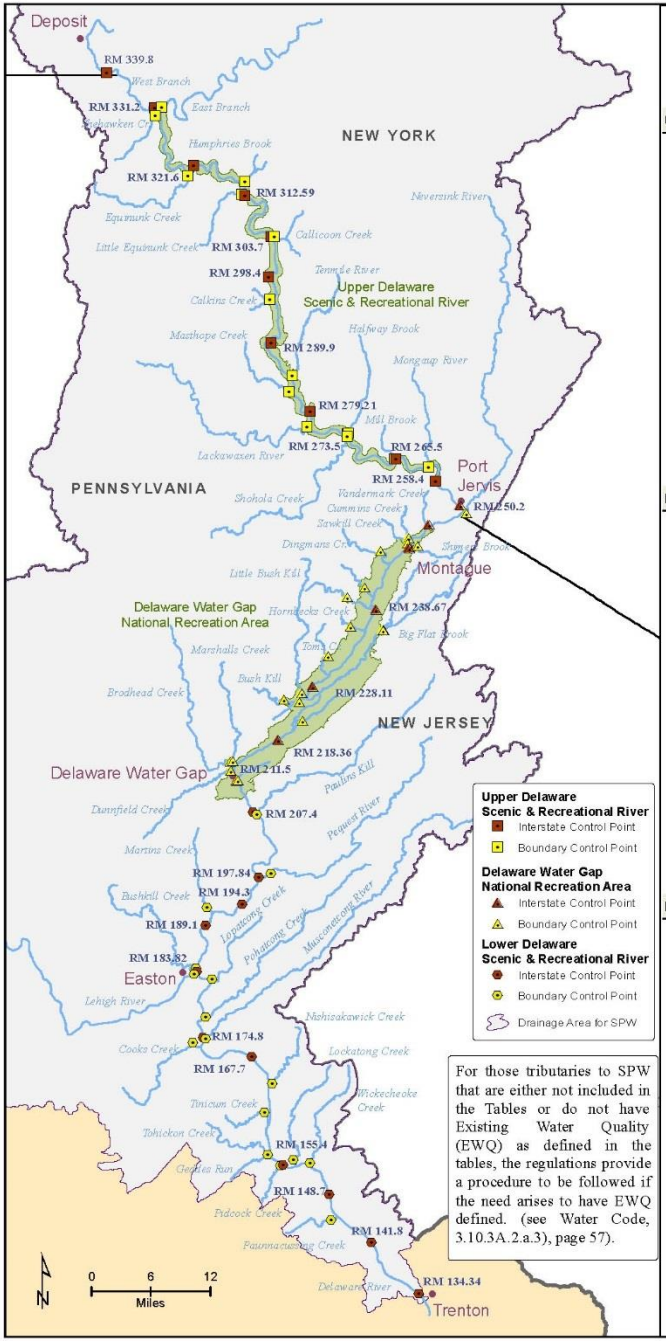
Tracking Estuary DO over time

Caveats:

- * Data is daytime spot measurements collected near surface
- * Criteria is 24-hour mean
- * Continuous and near-bottom data show persistent DO sag



Special Protection Waters Program



Boundary Control Points within the Special Protection Waters Drainage Area

River Mile	Site Name
Upper Delaware SRR	
331.2	West Branch Delaware River
330.7	East Branch Delaware River, NY
331	Shehawken Ck, PA
322.5	Equinunk Ck, PA
321.6	Delaware River at Lordville Bridge
314.1	Basket Ck, NY
312.7	Little Equinunk Ck, PA
312.59	Delaware River at Kellams Bridge
303.7	Delaware River at Callicoon Bridge
303.6	Callicoon Ck, NY
298.4	Delaware River at Damascus Bridge
295.6	Calkins Ck, PA
289.9	Delaware River at Narrowsburg Bridge
284.2	Terminle River, NY
282.5	Masthope Ck, PA
279.21	Delaware River at USGS Gage 01428500
277.71	Lackawaxen River, PA
273.5	Delaware River at Barryville Bridge
273.4	Halfway Brook, NY
273.2	Shohola Ck, PA
265.6	Mill Brook, NY
265.5	Delaware River at Pond Eddy Bridge
261.1	Mongaup River, NY
258.4	Delaware River at Millrift RR Bridge
Delaware Water Gap NRA	
254.75	Delaware RRA at Port Jervis Bridge
253.64	Neversink River, NY
250.2	Delaware River at DEWA Boundary
247.3	Vandermarck Ck, PA
247	Sawhill Ck, PA
246.6	Shiners Brook, NJ
246.38	Delaware River at Montague, NJ
243.9	Raymondskill Ck DEWA bdy PA
240.3	Adams Ck DEWA boundary, PA
239.2	Dingmans Ck DEWA bdy, PA
238.67	Delaware River at Dingmans Access
236.4	Hombecks Ck DEWA bdy, PA
230.4	Toms Ck DEWA boundary, PA
228.11	Delaware River at Bushkill Access
226.9	Bushkill Ck DEWA bdy, PA
226.9	Little Bushkill Ck DEWA bdy PA
226.9	Sand Hill Ck DEWA bdy, PA
225.3	Big Flatbrook DEWA bdy, NJ
225.3	Little Flatbrook DEWA bdy, NJ
219.9	Van Campens Bk DEWA bdy NJ
218.36	Delaware River at Smithfield Access
213	Brodhead Ck, PA
213	Marshalls Ck, PA
212.6	Cherry Ck, PA
211.5	Delaware River at Kittatiny Access
211.4	Dunfield Ck DEWA bdy, NJ
Lower Delaware Scenic and Recreational River	
207.4	Delaware River at Portland Foot Bridge
207	Paulins Kill, NJ
197.84	Delaware River at Belvidere Bridge
197.8	Pequest River, NJ
194.3	Delaware River at Martins Ck RR Bridge
190.65	Martins Ck, PA
184.1	Bushkill Ck, PA
183.82	Delaware River at Northampton St Bridge
183.66	Lehigh River, PA
182	Lopatcong Ck, NJ
177.4	Pohatcong Ck, NJ
174.8	Delaware River at Riegelsville Bridge
174.6	Musconong River, NJ
173.7	Cooks Ck, PA
167.7	Delaware River at Upper Black Eddy
164.1	Nishakawack Ck, NJ
161.6	Tinicum Ck, PA
157	Tohickon Ck, PA
155.6	Paunacussing Ck, PA
155.4	Delaware River at Bulls Island Footbridge
154	Lockatong Ck, NJ
152.5	Wickecheoke Ck, NJ
148.7	Delaware River at Lambertville Bridge
146.3	Pidcock Ck, PA
141.8	Delaware River at Washington Crossing
134.34	Delaware River at Calhoun St Bridge

For those tributaries to SPW that are either not included in the Tables or do not have Existing Water Quality (EWQ) as defined in the tables, the regulations provide a procedure to be followed if the need arises to have EWQ defined. (see Water Code, 3.10.3A.2.a.3, page 57).

- * “It is the policy of the Commission ... no measurable change in existing water quality except towards natural conditions ...”
- * Monitoring to define Existing Water Quality & Assess whether or not Existing Water Quality is being preserved
- * Water Quality models to assess impact of new or expanding WWTPs

Special Protection Waters Monitoring

- * **Nutrients & field measurements**
- * **Mainstem Delaware River stations**
 - Interstate Control Points (ICPs)
- * **Tributaries near confluence with Delaware**
 - Boundary Control Points (BCPs)
- * **Number of stations flexible from year to year depending on strength of definition of Existing Water Quality**



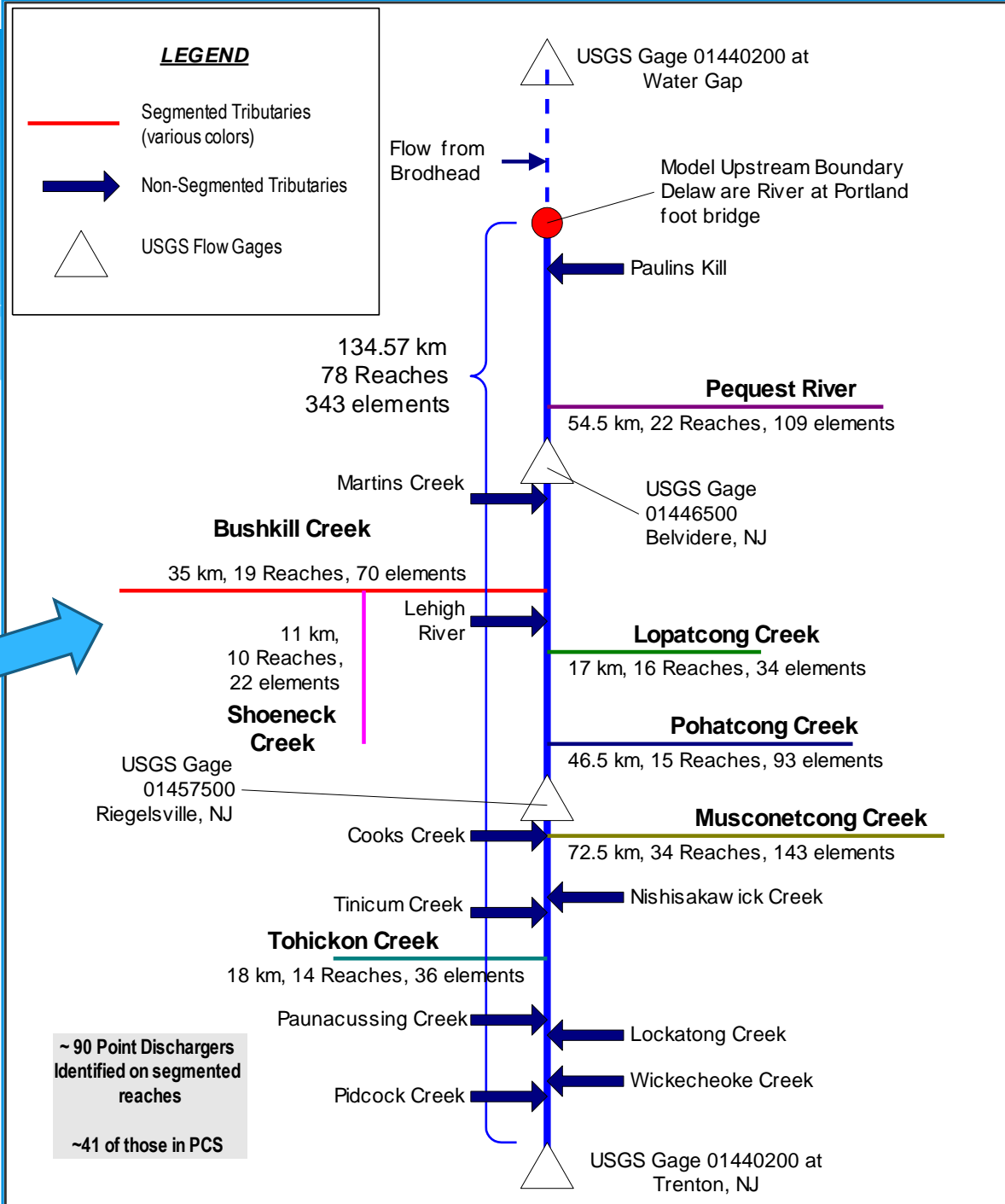
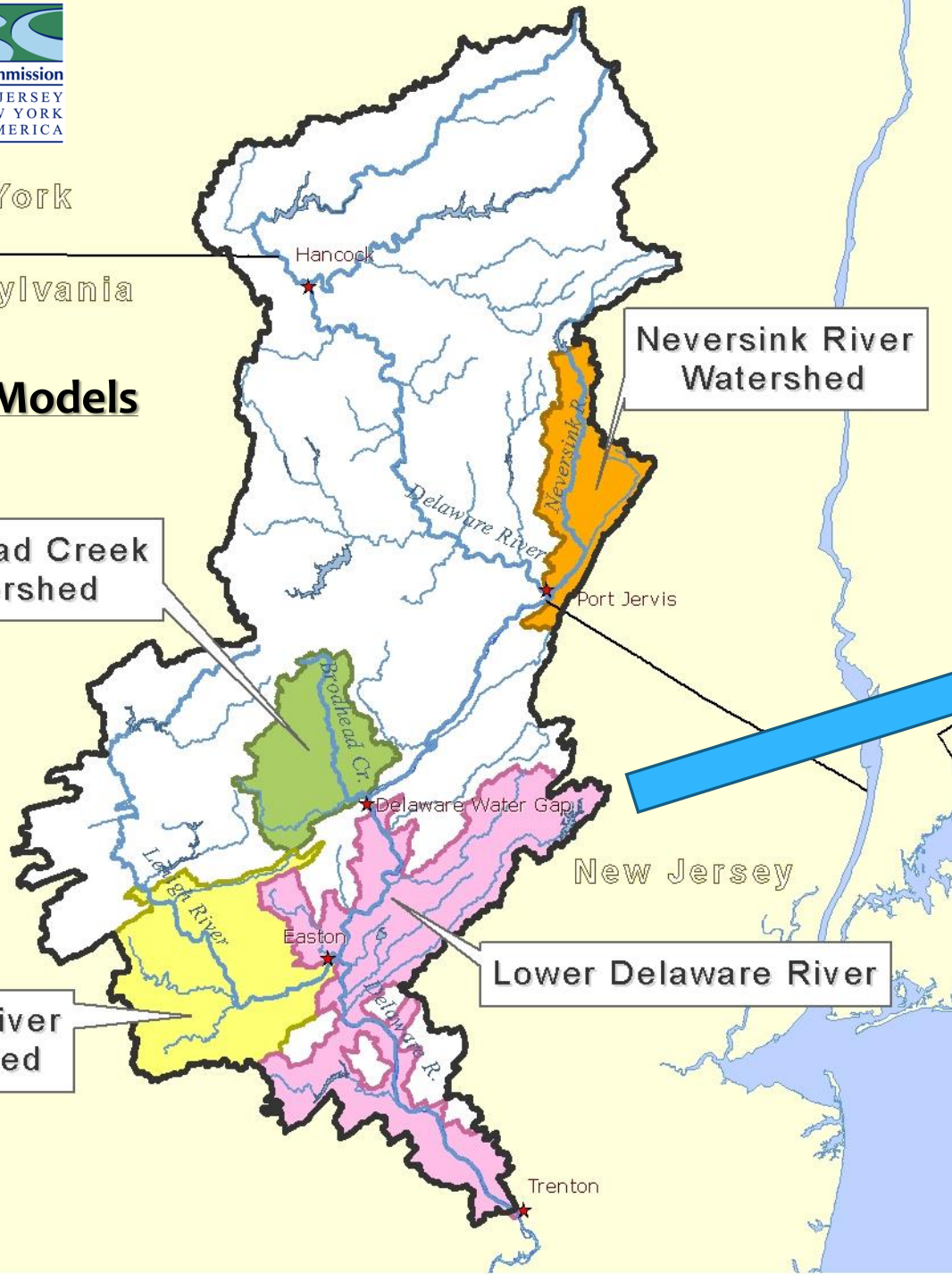
New York

Pennsylvania

QUAL2K Models

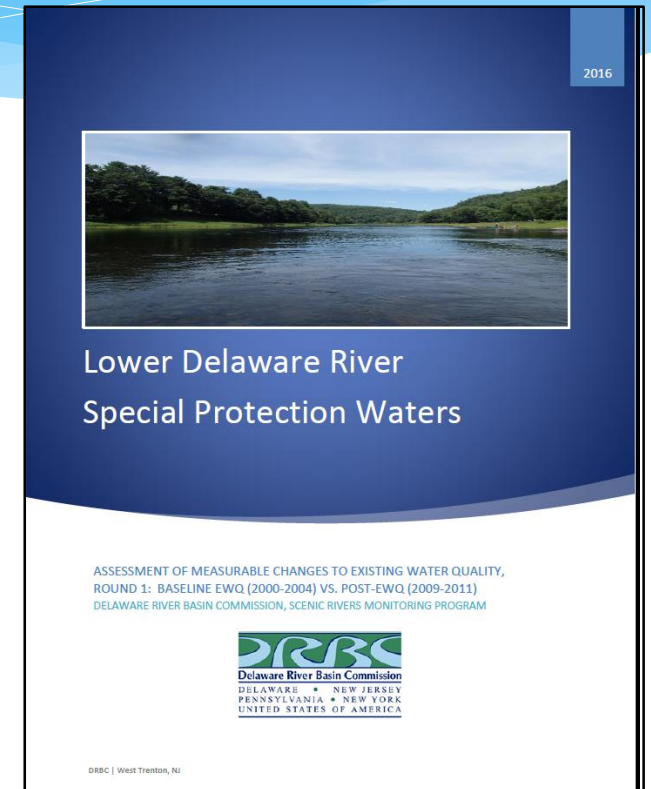
Brodhead Creek Watershed

Lehigh River Watershed



Special Protection Waters Data

- * Lower Delaware Measurable Change Assessment published August 2016
http://www.nj.gov/drbc/programs/quality/lower-delaware_EWQassessment2016.html
- * Canned database queries on DRBC web site at
<http://www.state.nj.us/drbc/quality/datum/>
- * Special Protection Waters Monitoring Program Explorer
<https://elainepanuccio.shinyapps.io/specialprotectionwatersexplorer/>



Summary Matrix of Measurable Changes: 440 Within-Site Comparisons at a Glance

Site Color Key		Dark Blue = Interstate Control Point (ICP)					Dark Red = Pennsylvania Tributary Boundary Control Point (BCP)					Dark Green = New Jersey Tributary Boundary Control Point (BCP)													
Parameter	Site--> Site Number-->	Del. River at Trenton	Del. River at Washngtn Crossing	Pidcock Creek, PA	Delaware River at Lambrtvle	Wicke-cheoke Creek, NJ	Lokatong Creek, NJ	Delaware River at Bulls Island	Pauna-cussing Creek, PA	Tohickon Creek, PA	Tinicum Creek, PA	Nishi-sakawick Creek, NJ	Del. River at Milford	Cooks Creek, PA	Musco-netcong River, NJ	Del. River at Rieglsvll	Pohat-cong Creek, NJ	Lehigh River, PA	Del. River at Easton	Bushkill Creek, PA	Martins Creek, PA	Pequest River, NJ	Del. River at Belvidere	Paulins Kill River, NJ	Del. River at Portland
		1343 ICP	1418 ICP	1463 BCP	1487 ICP	1525 BCP	1540 BCP	1554 ICP	1556 BCP	1570 BCP	1616 BCP	1641 BCP	1677 ICP	1737 BCP	1746 BCP	1748 ICP	1774 BCP	1837 BCP	1838 ICP	1841 BCP	1907 BCP	1978 BCP	1978 ICP	2070 BCP	2074 ICP
Field	Dissolved Oxygen (DO) mg/l										~														
	Dissolved Oxygen Saturation %										~														
	pH, units																								
	Water Temperature, degrees C																								
Nutrients	Ammonia Nitrogen as N, Total mg/l																								
	Nitrate + Nitrite as N, Total mg/l																**								
	Nitrogen as N, Total (TN) mg/l																**								
	Nitrogen, Kjeldahl, Total (TKN) mg/l																								
	Orthophosphate as P, Total mg/l																								
Phosphorus as P, Total (TP) mg/l																									
Bacteria	Enterococcus colonies/100 ml	~			~																				
	Escherichia coli colonies/100 ml	**	**	**	**	**	**			**	**	**													
	Fecal coliform colonies/100 ml																								
Conventional	Alkalinity as CaCO3, Total mg/l																								
	Hardness as CaCO3, Total mg/l											~													
	Chloride, Total mg/l			**		**	**	**	**	**		**	**	**	**	**	**	**	**	~	**	**	**	**	**
	Specific Conductance µmho/cm			**		**	**	~	**	**	**	**	**	**	**	~	**	**	~	~	~	**	~		
	Total Dissolved Solids (TDS) mg/l																								
	Total Suspended Solids (TSS) mg/l																								
Turbidity NTU																									
KEY		= No indication of measurable change to EWQ							** = Indication of measurable water quality change toward more degraded status					~ = Weak indication of measurable water quality change toward more degraded status											

Nutrient reductions corroborated by subsequent USGS assessment using different data, different methods

Good News:
 88% of water quality tests showed no degradation

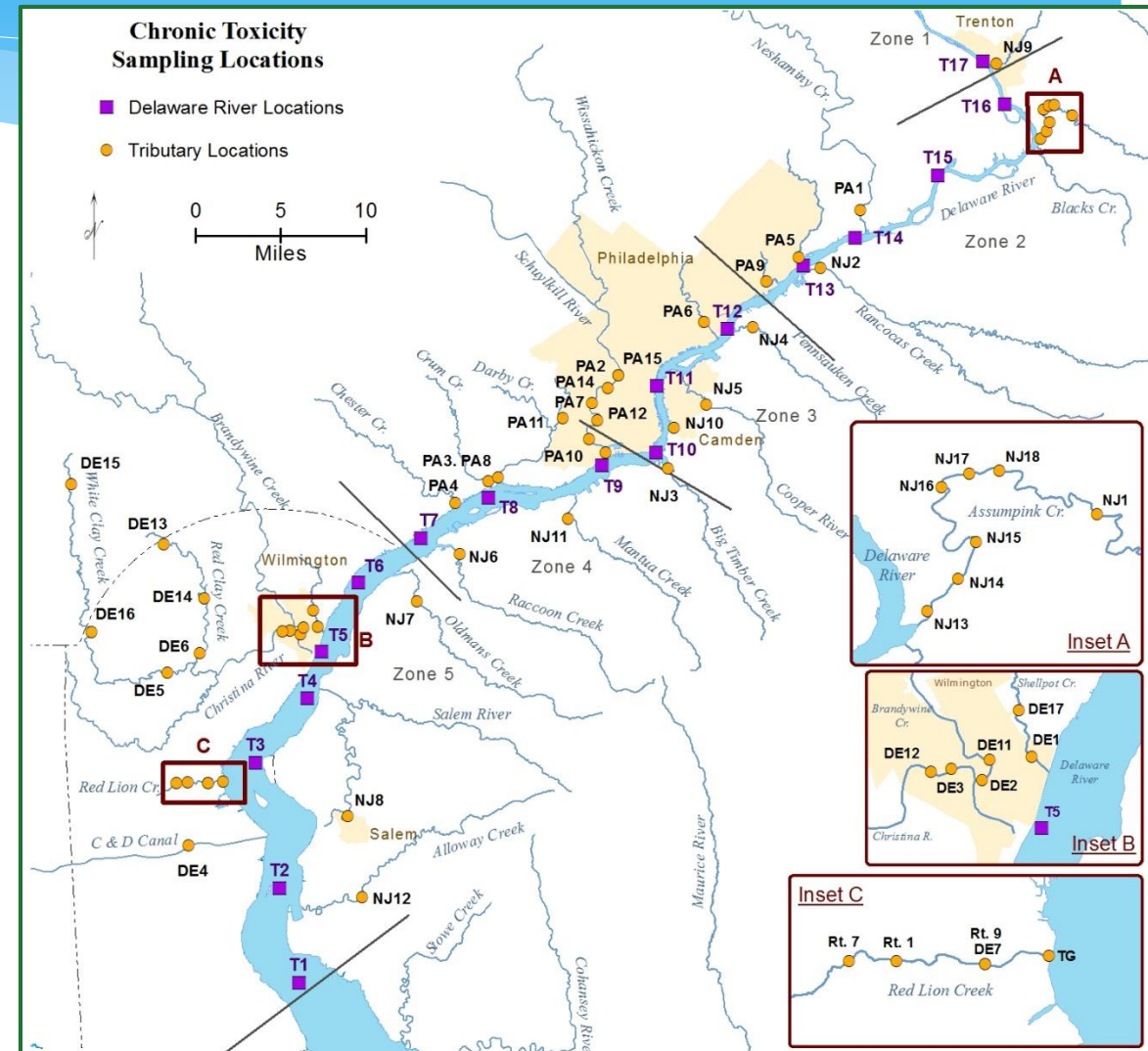
Biological Monitoring Program

- * **Macroinvertebrates & Periphyton**
- * **25 riffle sites in non-tidal Delaware River**
- * **Every 2 or 3 years**
- * **Assessment included in Delaware River Water Quality Assessment (305(b))**
- * **Databases to be accessible via DRBC web site in 2018 (stay tuned)**



Ambient Toxicity

- Surface Water Samples
- Detect *interactive* toxic effects of *mixtures* of chemicals
- Laboratory Tests using USEPA Short-Term Chronic Methods
- Freshwater and Estuarine species
- 1990 to present, 3 to 5 year cycle
- 2015 & 2016 in cooperation with DNREC WATAR program
- Next sampling proposed for main stem in 2018



Special Projects

* Natural Gas Baseline Monitoring

- Biological Monitoring
- Conductivity Loggers
- Radiochemistry
- Archived samples, barium & strontium

* SPW Model Calibration Monitoring

- Brodhead, Neversink, & Lehigh Watersheds

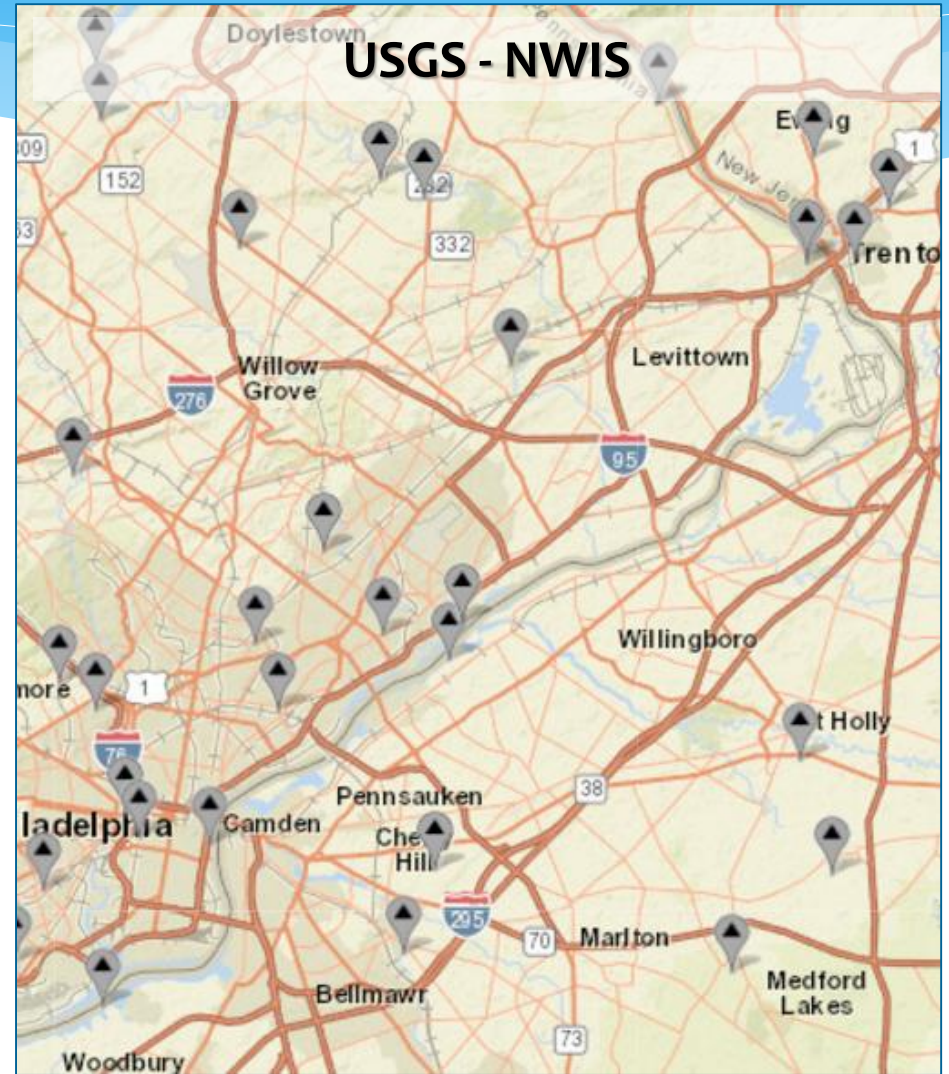
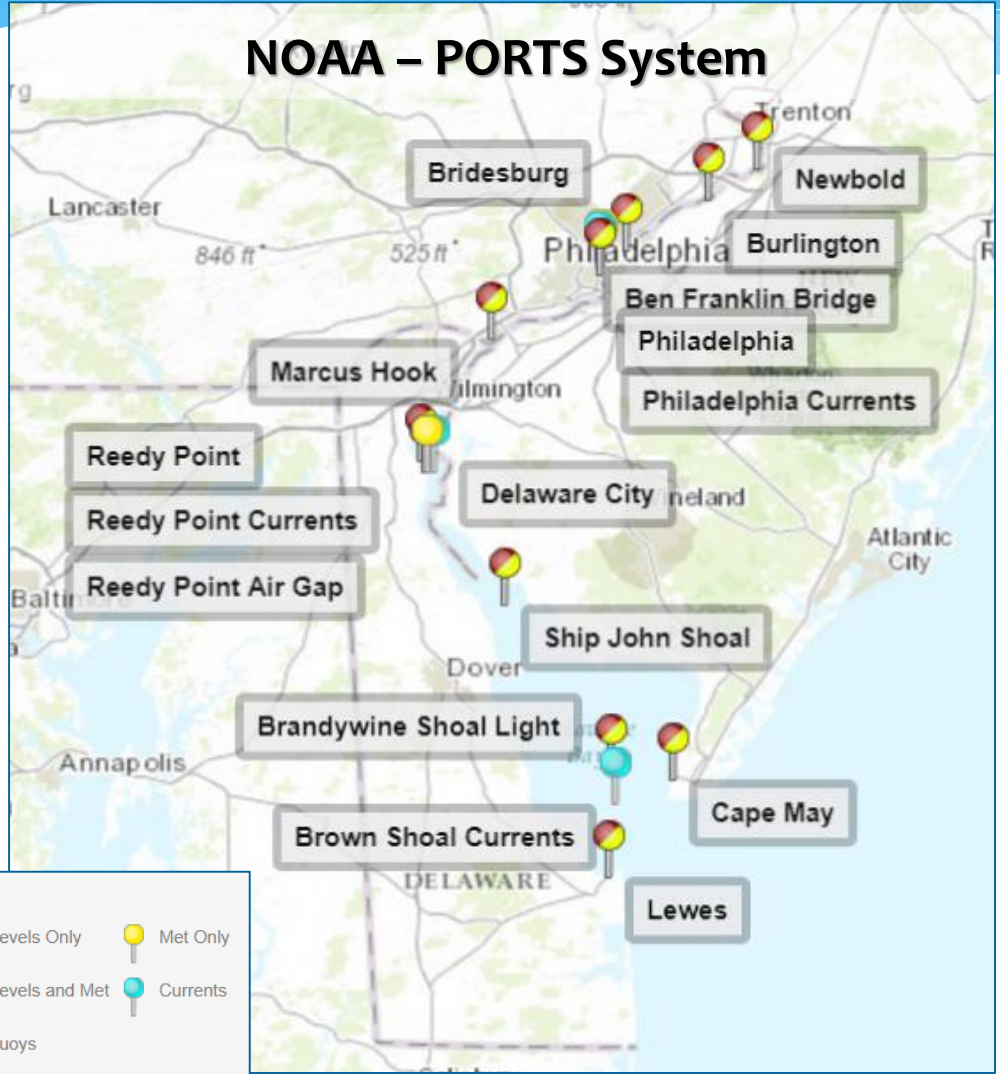
* Response Monitoring

- Vinyl Chloride spill response monitoring
- Estuary tritium, gross alpha, gross beta emitters



How we use data generated by others

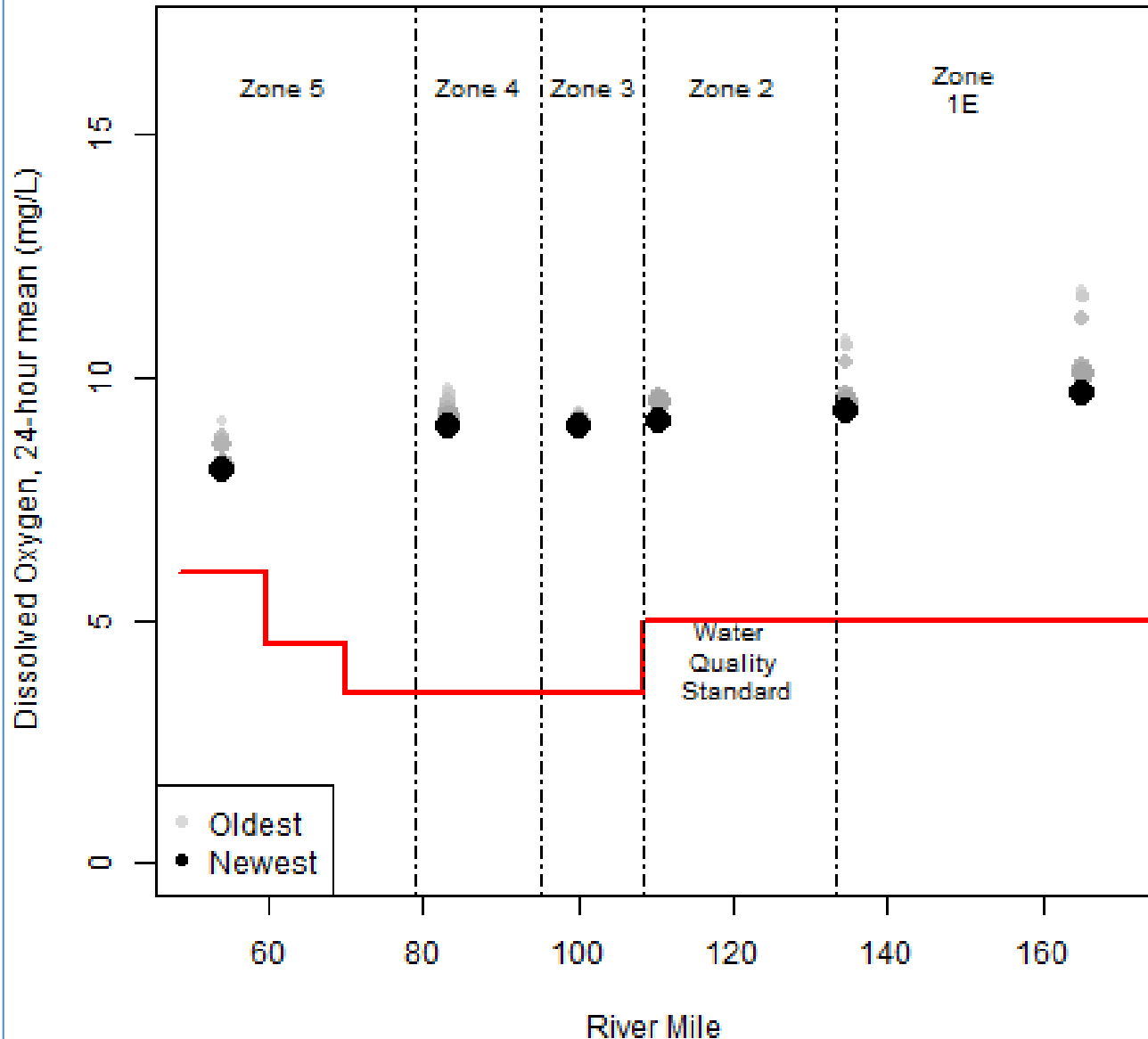
USGS-NWIS and NOAA-PORTS



Using Data Generated by Others: Flow & Water Quality Dashboards

- * **Near Real-Time Water Quality & Flow Dashboards**
- * **Pulls data from USGS and NOAA via the internet**
- * **Automated scripted processing and plotting of data**
- * **Comparisons to criteria and thresholds**
 - <http://drbc.net/Sky/waterq.htm>
 - <http://drbc.net/Sky/flows.htm>

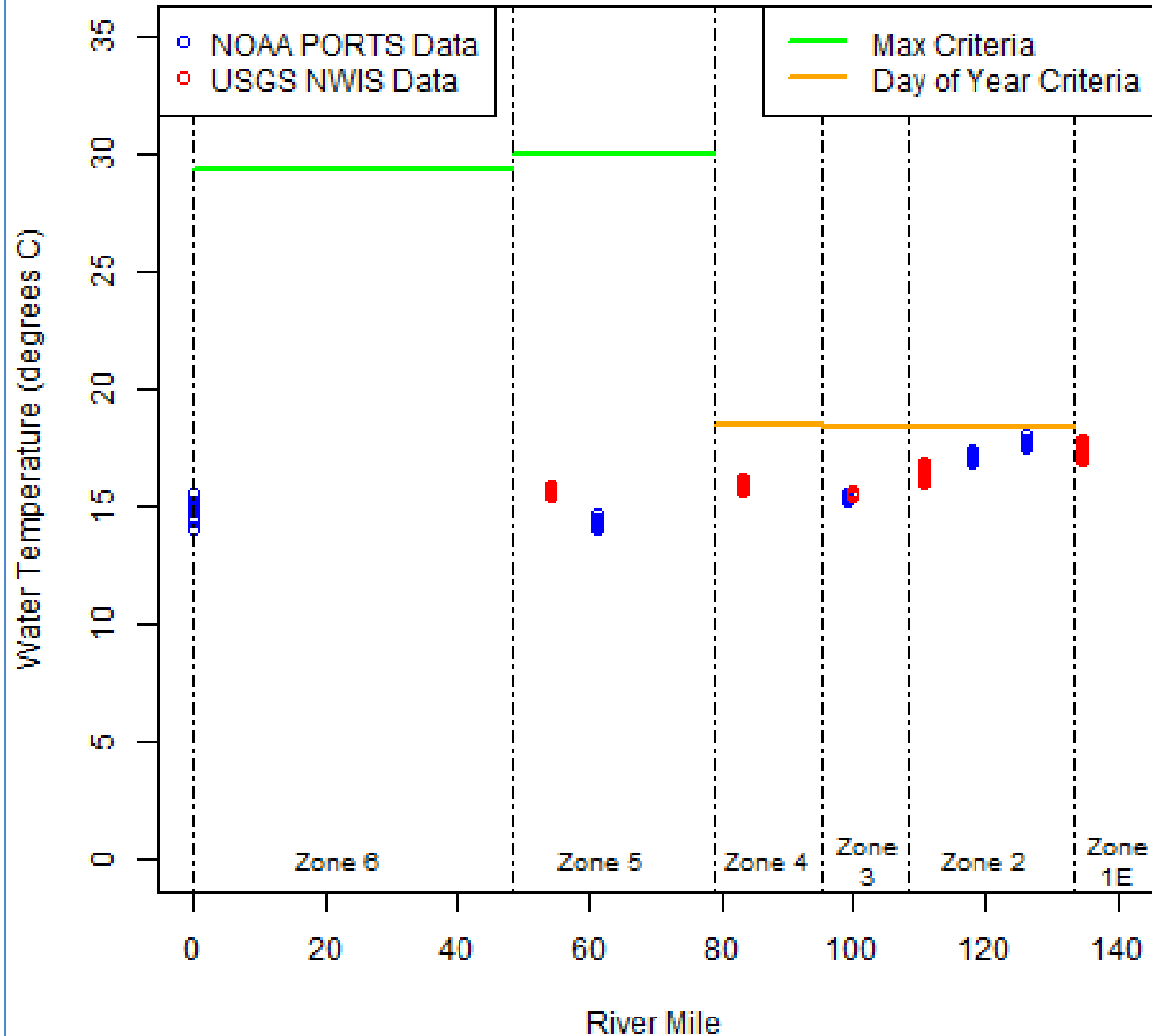
Delaware River Dissolved Oxygen Concentrations 05/01/2018 to 05/06/2018 and Standards



Water Quality Dashboard

- * Last 5-days Dissolved Oxygen compared to Criteria

Delaware River Temperatures and Standards, 05/06/2018

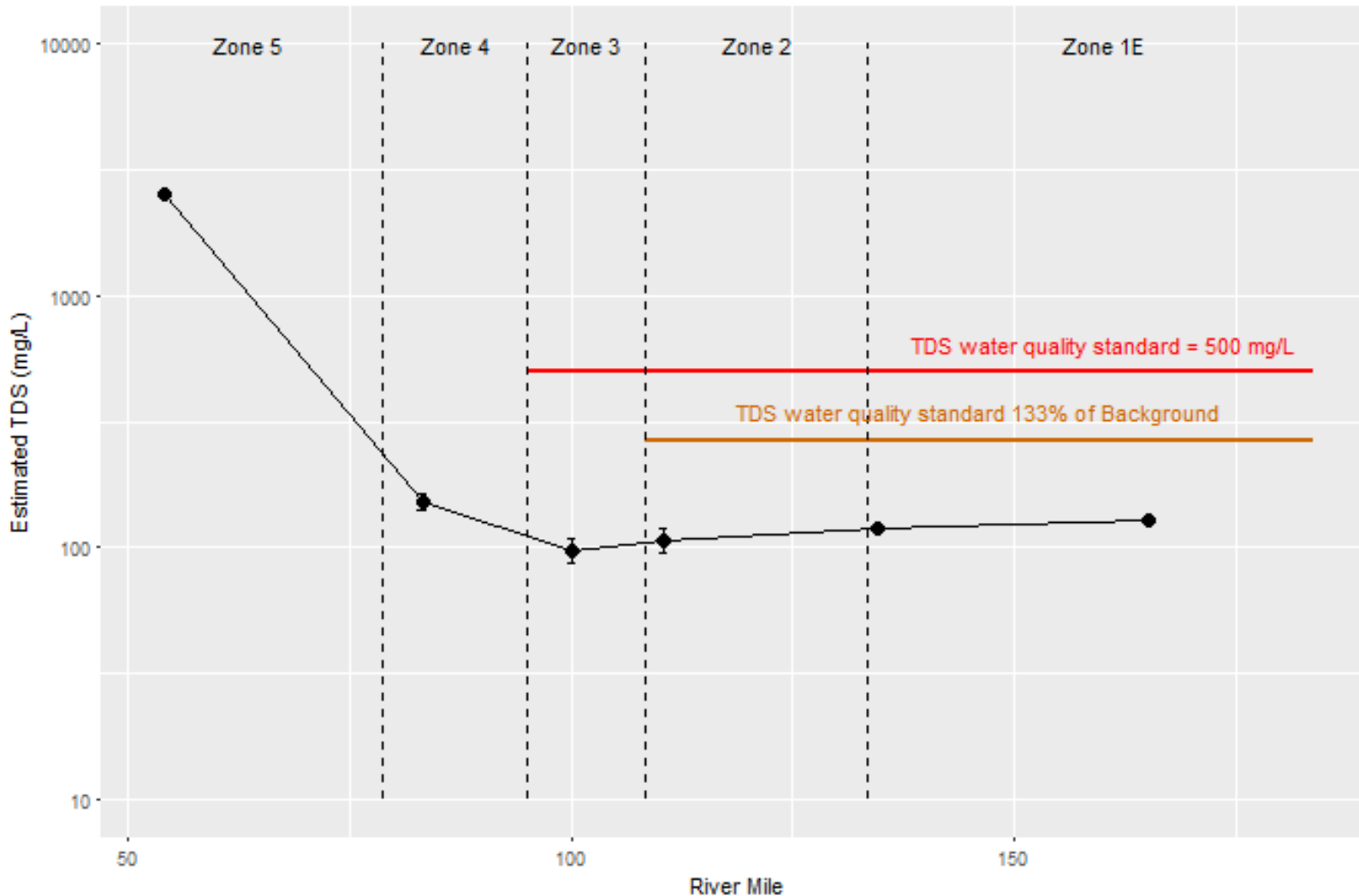


Water Quality Dashboard

- * Temperature from both NWIS and NOAA-PORTS compared to Criteria

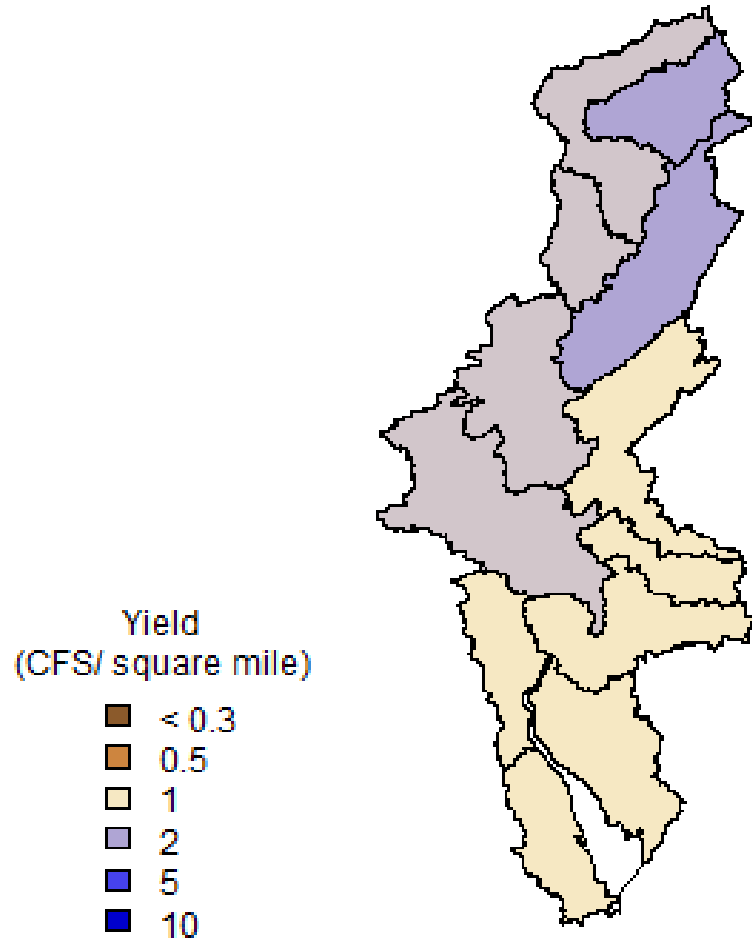
Water Quality Dashboard

Mainstem Delaware River estimated maximum Total Dissolved Solids on 05/06/2018
Derived from USGS continuous Specific Conductance measurements



- * Reads specific conductance, converts to TDS using a regression relationship, plots TDS compared to criteria

**Delaware Basin daily water Yield
(CFS/square mile) on 04/19/2016**

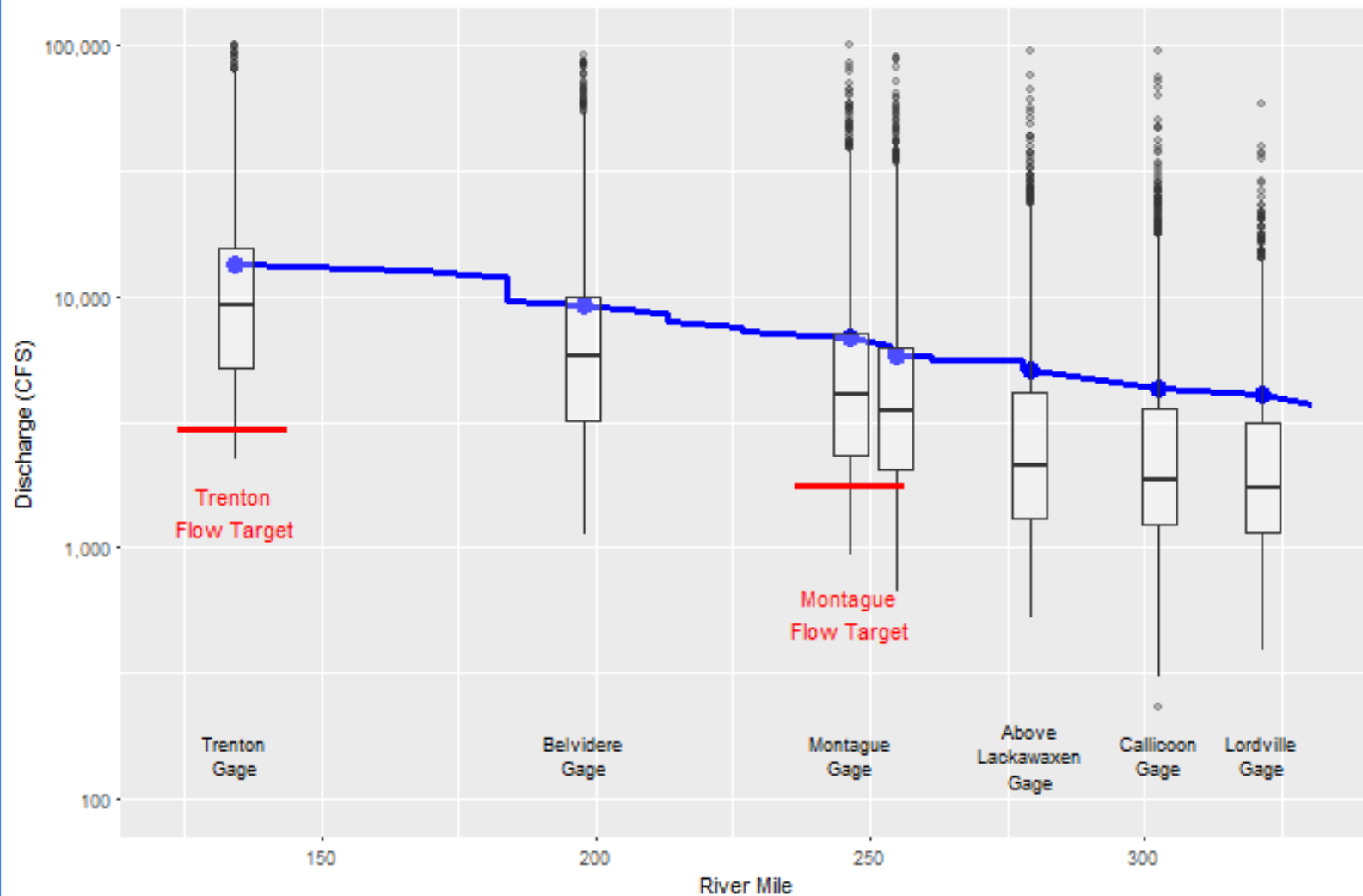


Flow Dashboard

- * Animated map of water yields by HUC8 for last several days
- * Pulls, processes, and plots data from ~140 USGS gages

Flow Dashboard

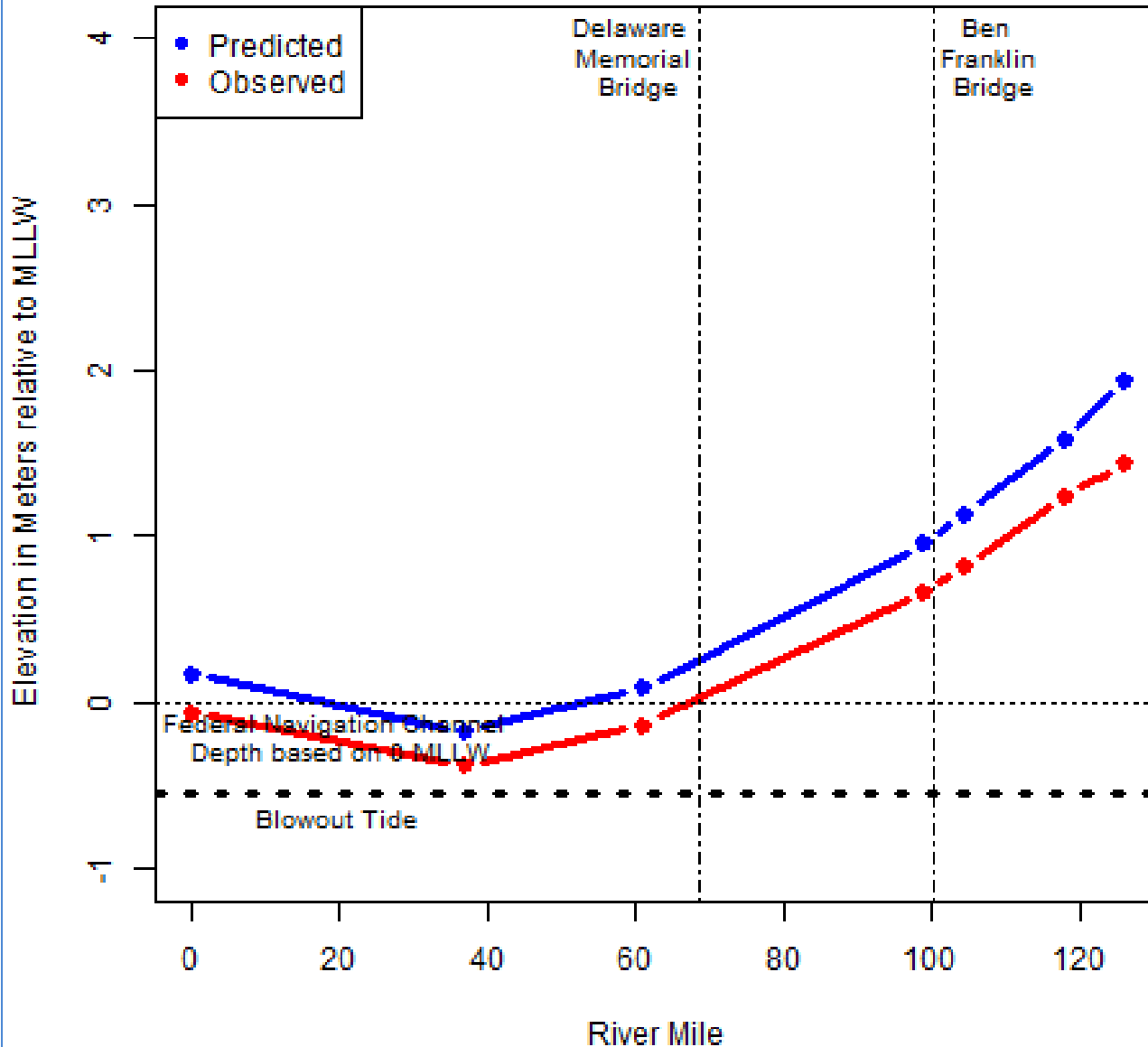
Mainstem Delaware River Discharge Profile on 05/06/2018
Compared to 20-year Boxplots at USGS Gage Sites



- * Generates 20-year boxplots for each gage (goalpost)
- * Generates profile plot including inflows from major tributaries to show how current condition compares

Flow Dashboard

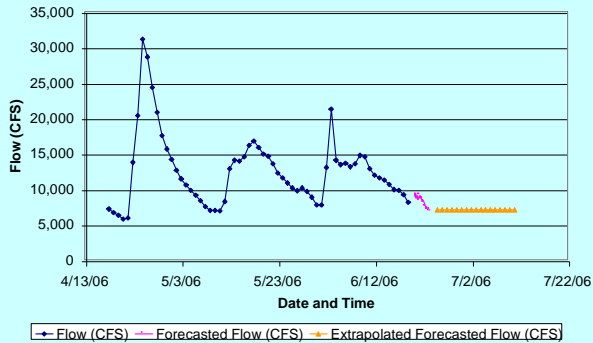
Delaware Estuary Water Surface Elevation, 12/29/2017 00:00
Data retrieved 01/02/2018



- * Pulls observed and predicted water surface elevation data from NOAA-PORTS system
- * Animated plot of last several days

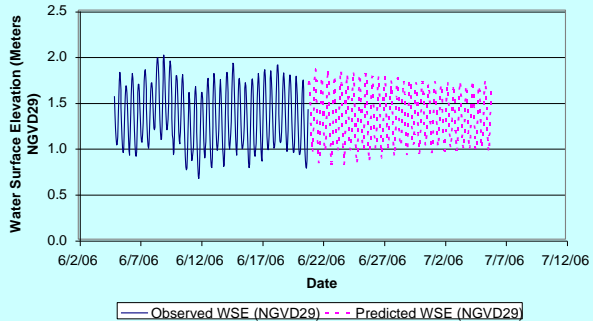
Automated Daily Processes No User Input Required

Measured, Forecasted, and Extrapolated Forecasted Flows
at the Delaware River at Trenton (USGS Station 01463500)



**Freshwater
Boundary
Discharge Data
and Predictions**

Observed and Predicted Water Surface Elevation, C&D Canal at
Chesapeake City, MD
NOAA Station 8573927



**Tidal Boundary
Water Surface
Data and
Predictions**

**Pre-Processor
develops model
input file**

DYNHYD5

WASP

**Spill
Data**

**Predicted Location,
Duration, and
Concentration of
Impacted Water Intakes**

**Prescriptive Measures to
Mitigate Impact**

Water Quality Simulation in Response to Spill Event

Using Data Generated by Others: Overnight Hydrodynamic Model

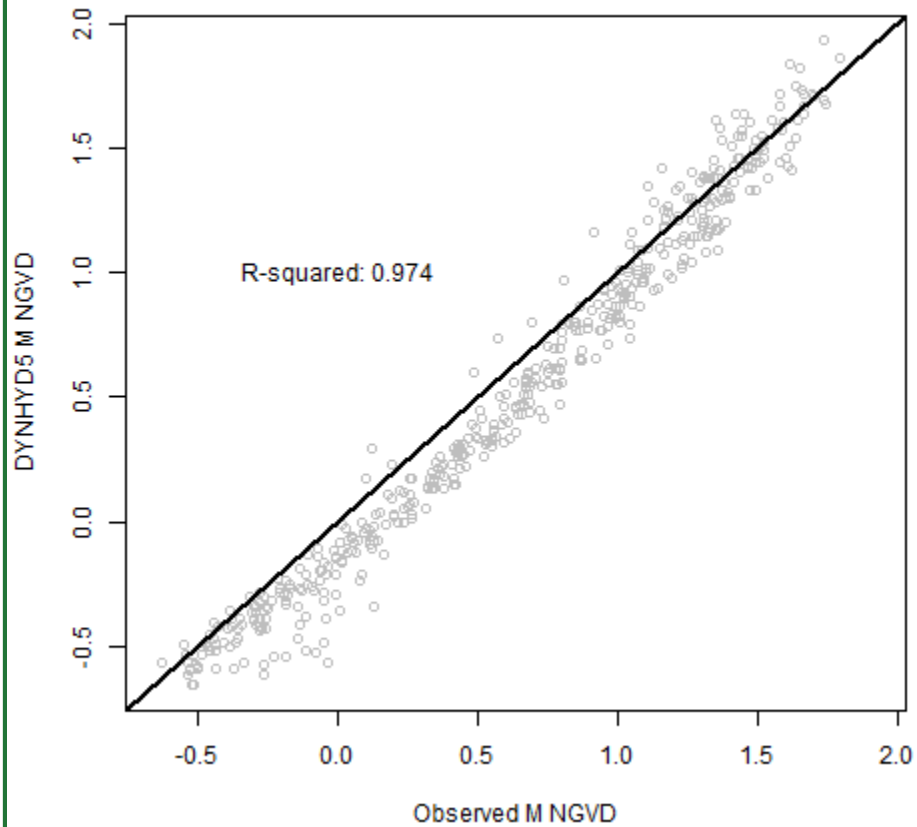
- * Pulls data from NOAA-PORTS, USGS, and AHPS overnight via internet
- * Automated scripts formulate the data into an input file for existing model
- * Runs existing DYN5 model using new data
- * In the event of a spill, manually feed the output to WASP water quality model to simulate concentration, duration, and movement of plume

Continued Automated Model Development

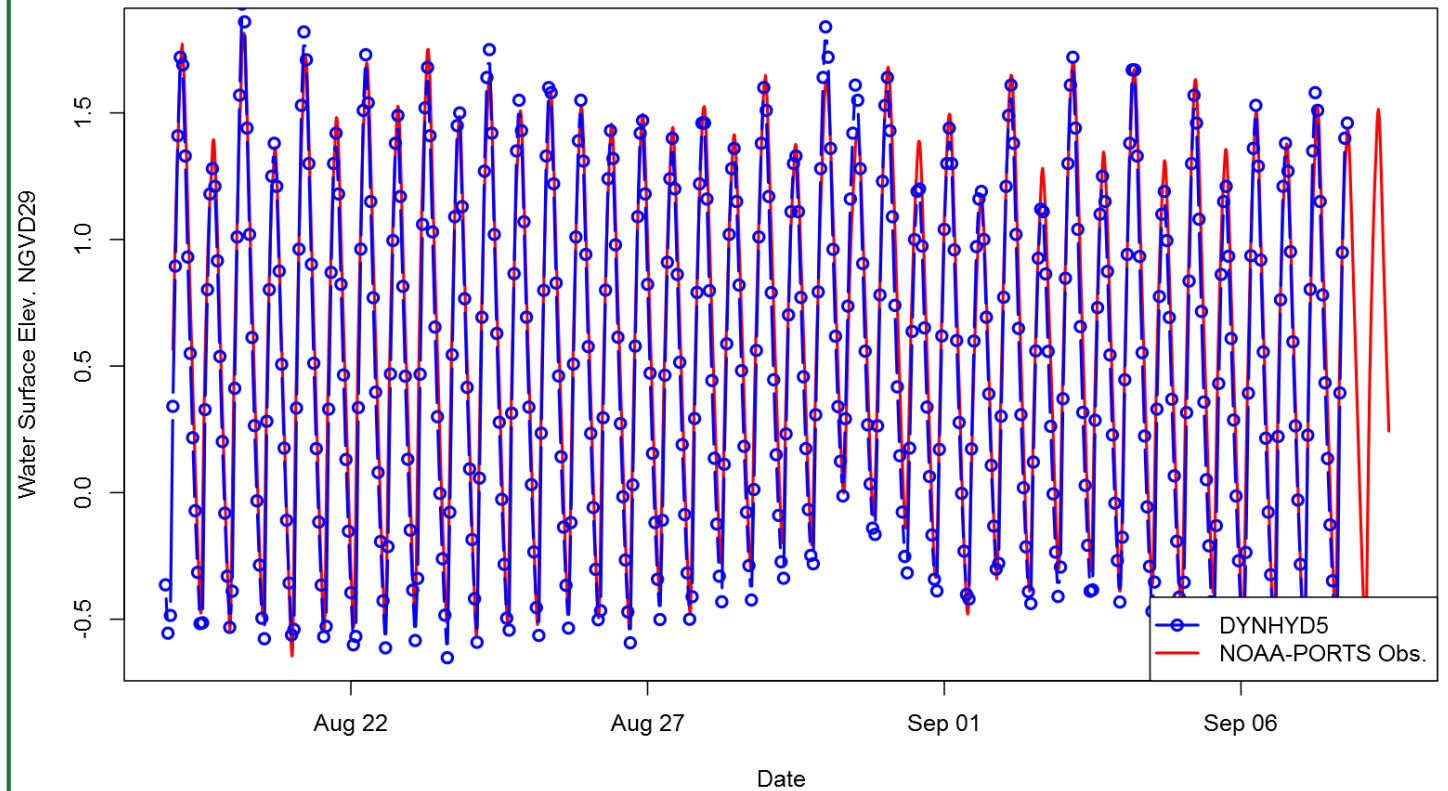
- * Earliest version utilized VBA scripts for pulling & processing data
 - <http://onlinelibrary.wiley.com/doi/10.1111/jawr.12185/abstract>
- * From fully automated to mostly automated in 2017 – human interaction is key
- * Migrated pulling & processing to R in 2017
- * Added daily calibration checks in 2017
- * Expect to replace 1-D DYNHYD model with coarse and fine grid EFDC models in 2019

Automated Daily Calibration Checks

20-day Bivariate Modeled and Observed WSE Philadelphia_USGS
Simulated: 2017-09-08



20-day Comparison DYNHYD5 Channel 46 Upstream Junction to Observed at
Philadelphia_USGS Simulated: 2017-09-08 RMSE: 0.1572





Questions & Discussion

John.Yagecic@drbc.nj.gov

<http://www.nj.gov/drbc/quality/datum/>

<https://adventuresindata.blogspot.com/>

Featured DRBC Staff

Ron MacGillivray, Ph.D.	Namsoo Suk, Ph.D.
Elaine Panuccio	Greg Cavallo
Tom Fikslin, Ph.D.	Erik Silldorff, Ph.D. (former)
Bob Limbeck (retired)	Many many interns!

