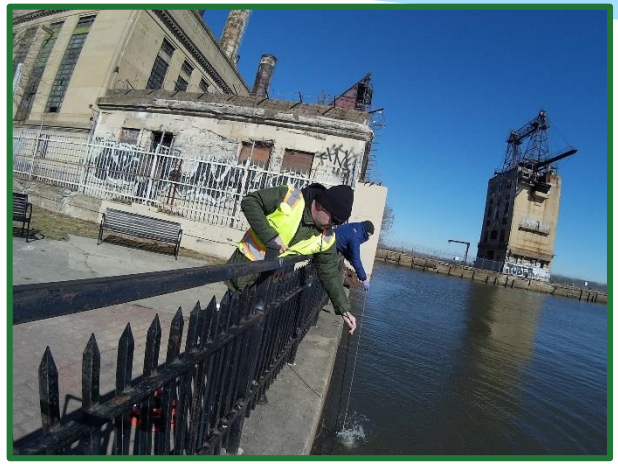
Delaware River Basin Commission

Using Data To Manage Delaware River Basin Water Resources

AWRA Philadelphia

John Yagecic, P.E.
Manager, Water Quality Assessment



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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

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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

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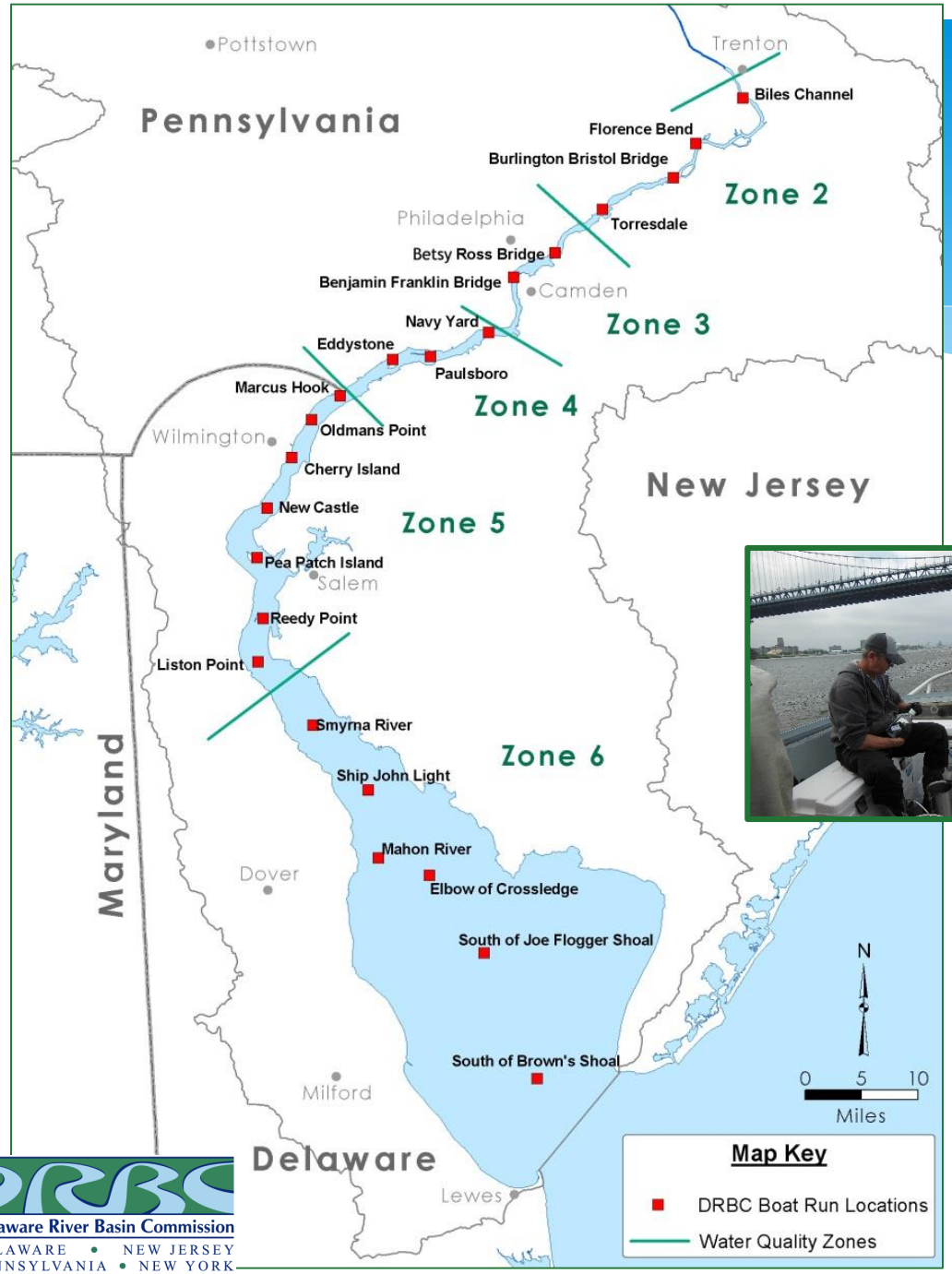
Delaware Estuary Water Quality Monitoring (Boat Run)



- 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

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How we use the Delaware Estuary water quality data

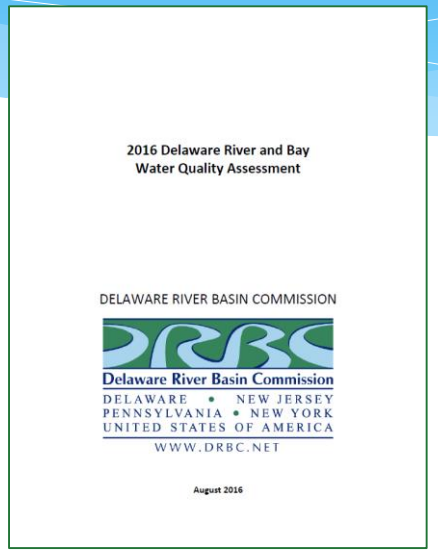
* **Delaware River & Bay Water Quality Assessment Report**
  - **CWA 305(b)**
  - **Every even numbered year**

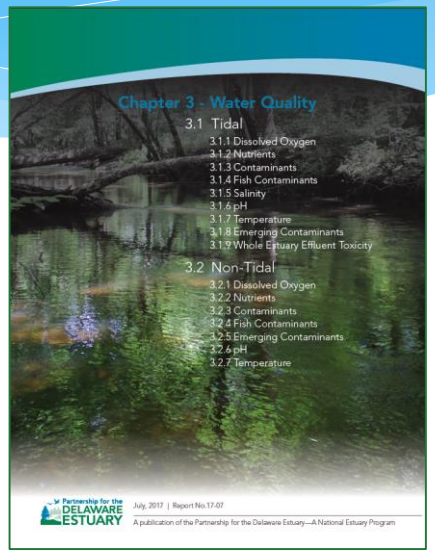
* **State of the Estuary Report**
  - **Cooperation with Partnership for the Delaware Estuary (PDE)**
  - **~ Every 5 years**

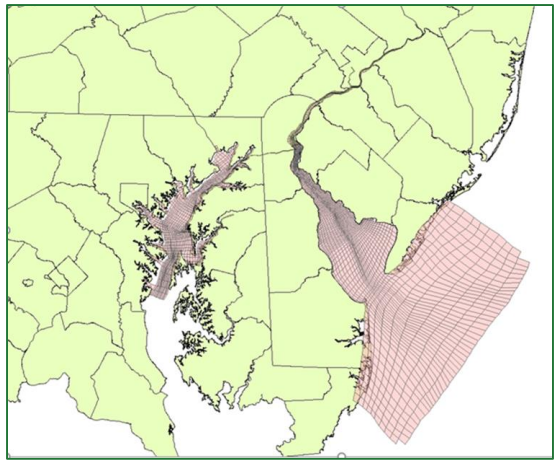
* **Estuary Eutrophication Model (under development)**

* **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/**







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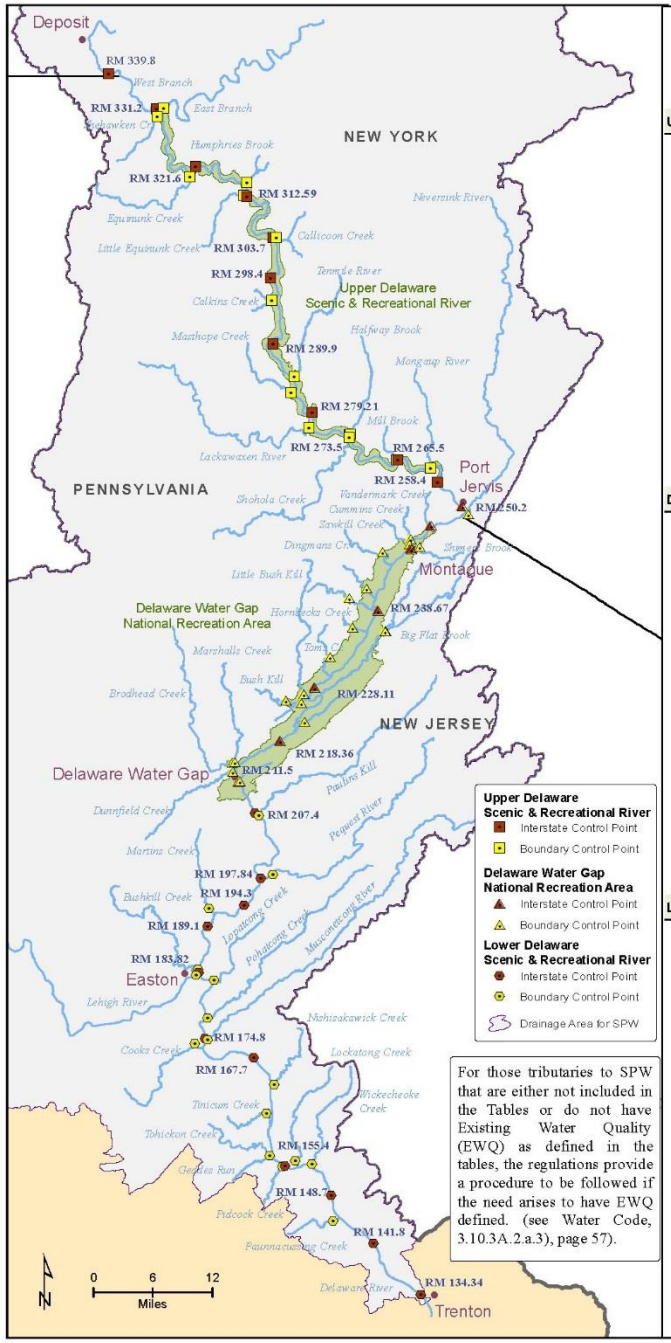

Boundary Control Points within the Special Protection Waters Drainage Area

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	Tenmile 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 River at Port Jervis Bridge
253.64	Neversink River, NY
250.2	Delaware River at DEWA Boundary
247.3	Vandermark Ck, PA
247	Sawkill Ck, PA
246.6	Shimers 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	Hornbecks 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 Kittatinny Access
211.4	Dunnfield 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	Musconetcong River, NJ
173.7	Cooks Ck, PA
167.7	Delaware River at Upper Black Eddy
164.1	Nishisakawick Ck, NJ
161.6	Tinicum Ck, PA
157	Tohickon Ck, PA
155.6	Paunnacussing 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

Special Protection Waters Program

* "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

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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

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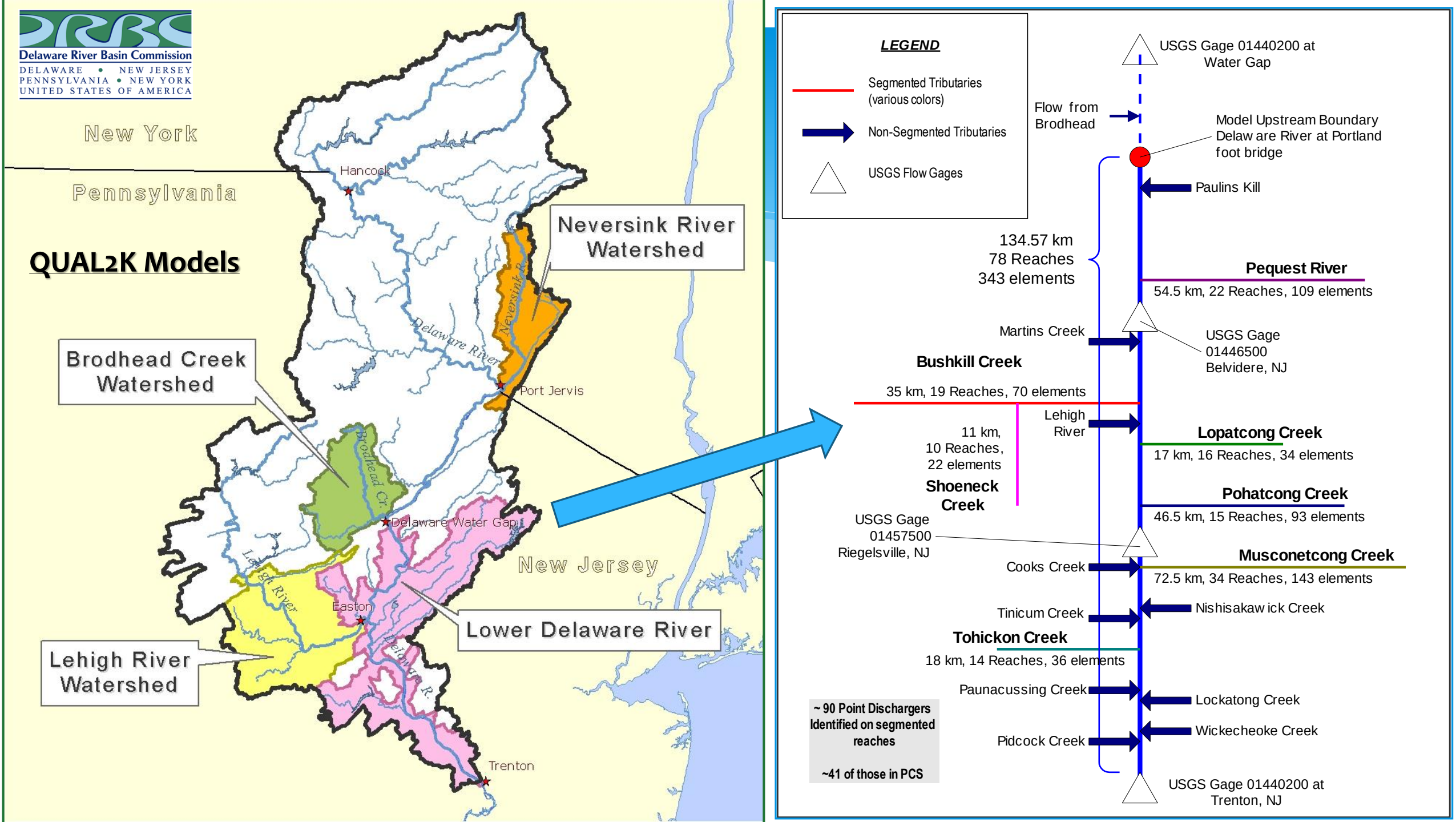
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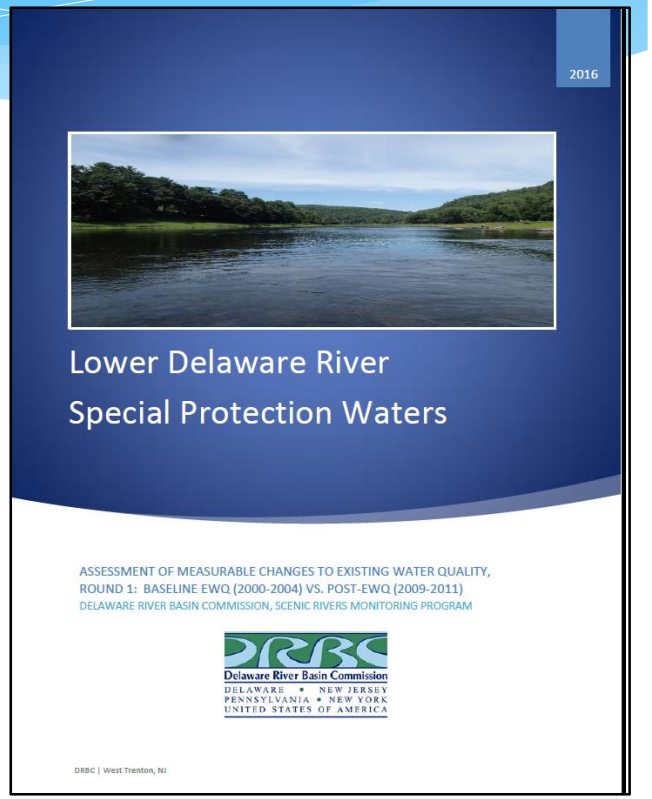
New York
Pennsylvania
New Jersey
QUAL2K Models
Neversink River Watershed
Brodhead Creek Watershed
Lehigh River Watershed
Lower Delaware River
Hancock
Port Jervis
Delaware Water Gap
Easton
Trenton
Neversink R.
Delaware River
Brodhead Cr.
Lehigh River
Delaware R.
LEGEND
Segmented Tributaries (various colors)
Non-Segmented Tributaries
USGS Flow Gages
USGS Gage 01440200 at Water Gap
Flow from Brodhead
Model Upstream Boundary Delaw are River at Portland foot bridge
Paulins Kill
134.57 km
78 Reaches
343 elements
Pequest River
54.5 km, 22 Reaches, 109 elements
Martins Creek
USGS Gage 01446500 Belvidere, NJ
Bushkill Creek
35 km, 19 Reaches, 70 elements
Lehigh River
11 km, 10 Reaches, 22 elements
Shoeneck Creek
Lopatcong Creek
17 km, 16 Reaches, 34 elements
Pohatcong Creek
46.5 km, 15 Reaches, 93 elements
USGS Gage 01457500 Riegelsville, NJ
Musconetcong Creek
72.5 km, 34 Reaches, 143 elements
Cooks Creek
Nishisakaw ick Creek
Tinicum Creek
Tohickon Creek
18 km, 14 Reaches, 36 elements
Paunacussing Creek
Lockatong Creek
Wickecheoke Creek
Pidcock Creek
~ 90 Point Dischargers Identified on segmented reaches
~41 of those in PCS
USGS Gage 01440200 at Trenton, NJ

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/



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

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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--->	Del. River at Trenton	Del. River at Washngtn Crossing	Pidcock Creek, PA	Delaware River at Lambrtvlle	Wicke-cheoke Creek, NJ	Lockatong 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
	Site Number--->	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																								
Conventionals	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																								

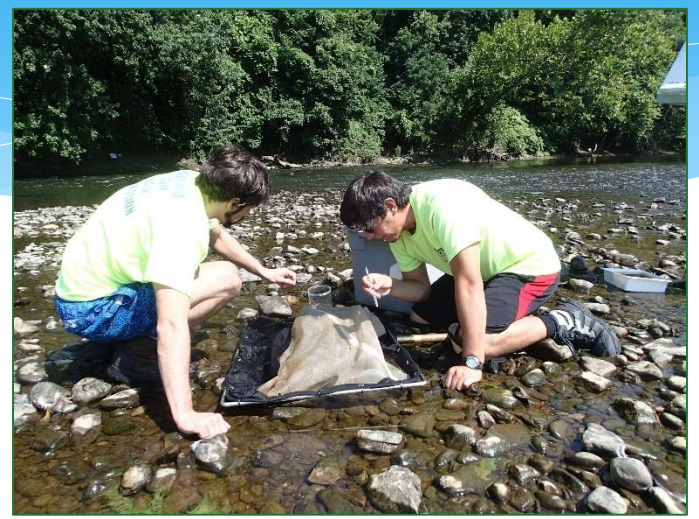
KEY: = No indication of measurable change to EWQ; ** = Indication of measurable water quality change toward more degraded status; ~ = Weak indication of measurable water quality change toward more degraded status

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)



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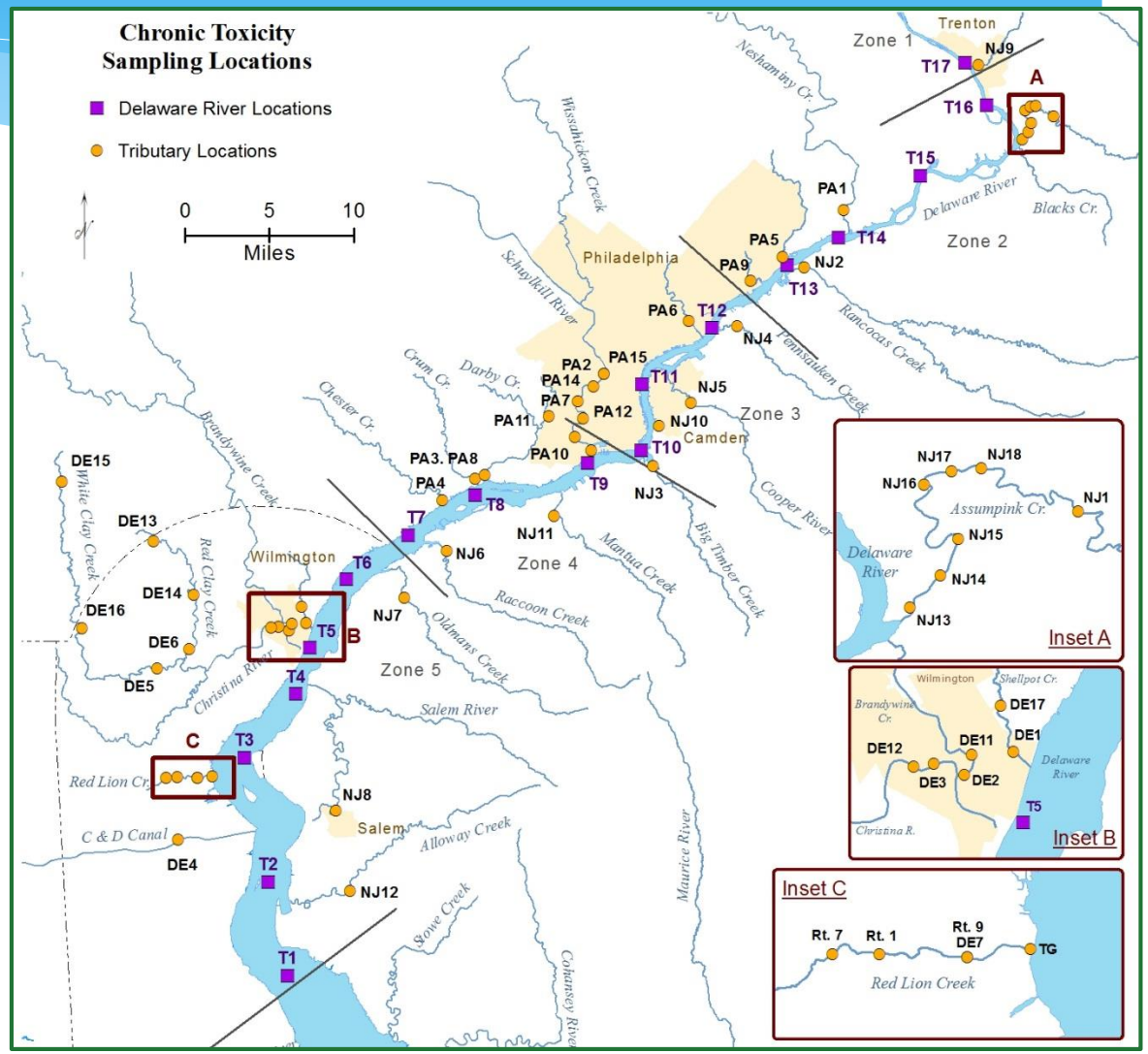
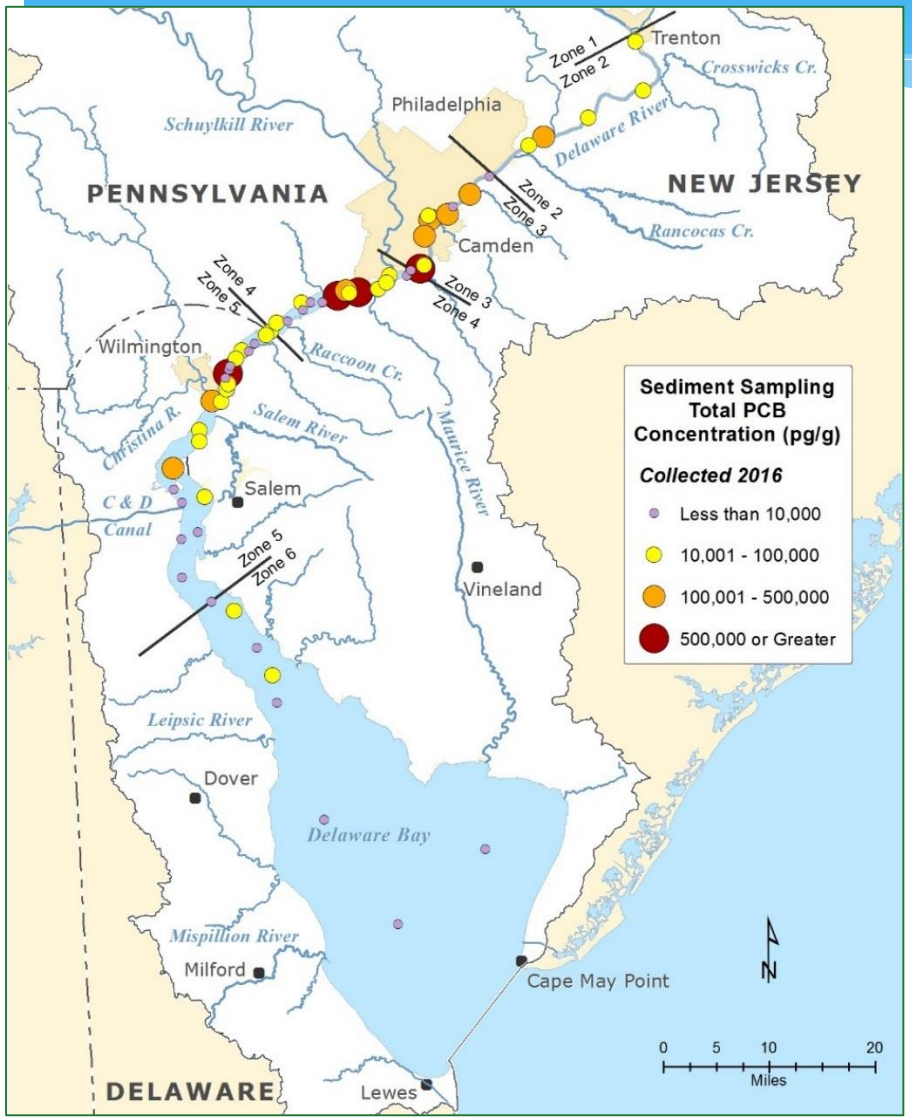
Ambient Toxicity

- 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



Sediment Monitoring



* Periodic
* PCBs, PAHs, perflourinated compounds, emerging contaminants
* Monitoring recovery under PCB TMDL, special studies in support of states, document background conditions

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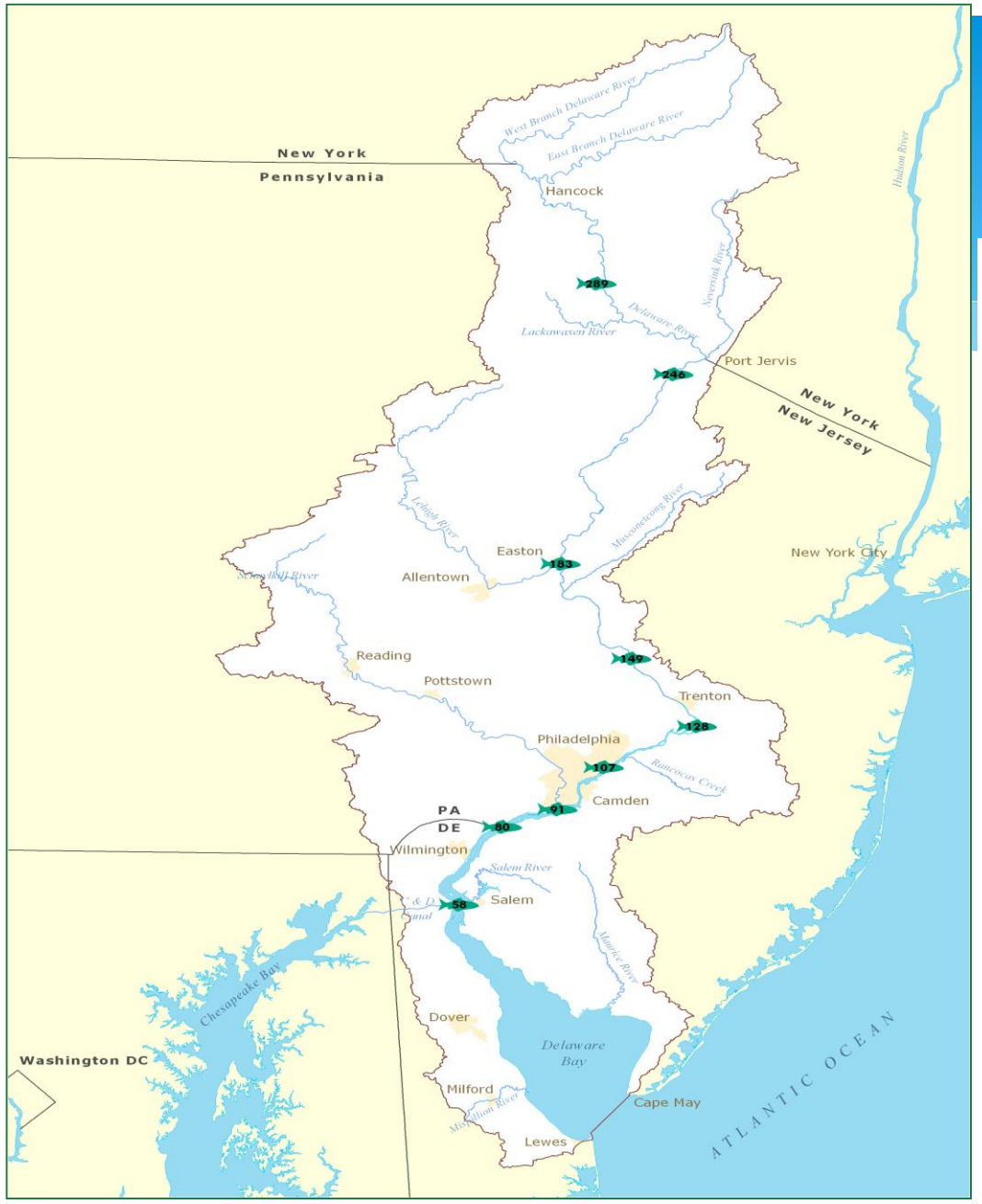

Fish Tissue Monitoring

* 8 or 9 sites in both tidal (5 sites) and non-tidal (3 - 4 sites) Delaware River.

* Frequency: Yearly 2000 - 2007, 2010, 2012, 2015, 2016 (Delaware Bay), 2018 (planned)

* Two fish species at each site representing benthic and pelagic trophic levels.
  - Tidal: white perch, channel catfish
  - Non-tidal: smallmouth bass, white sucker

* PCBs, Mercury, Methylmercury, Chlorinated pesticides, Dioxins/Furans, Perfluorinated Compounds, Metals

* Data used for fish consumption advisories by NJ

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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

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Special Projects (continued)

* **Aquatic Life Studies**
  - Lower non-tidal Delaware Mussel Survey
  - Didymo Survey
    - *Didymosphenia geminate*, native diatom alga but prone to blooms
  - Matlock Periphytometer Study

* **Winter Estuary Ammonia monitoring**

* **Support for other organizations**
  - PWD dye study support
  - Support to Shad young-of-year survey
  - Periodic Emerging Contaminant monitoring

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How we use data generated by others
USGS-NWIS and NOAA-PORTS

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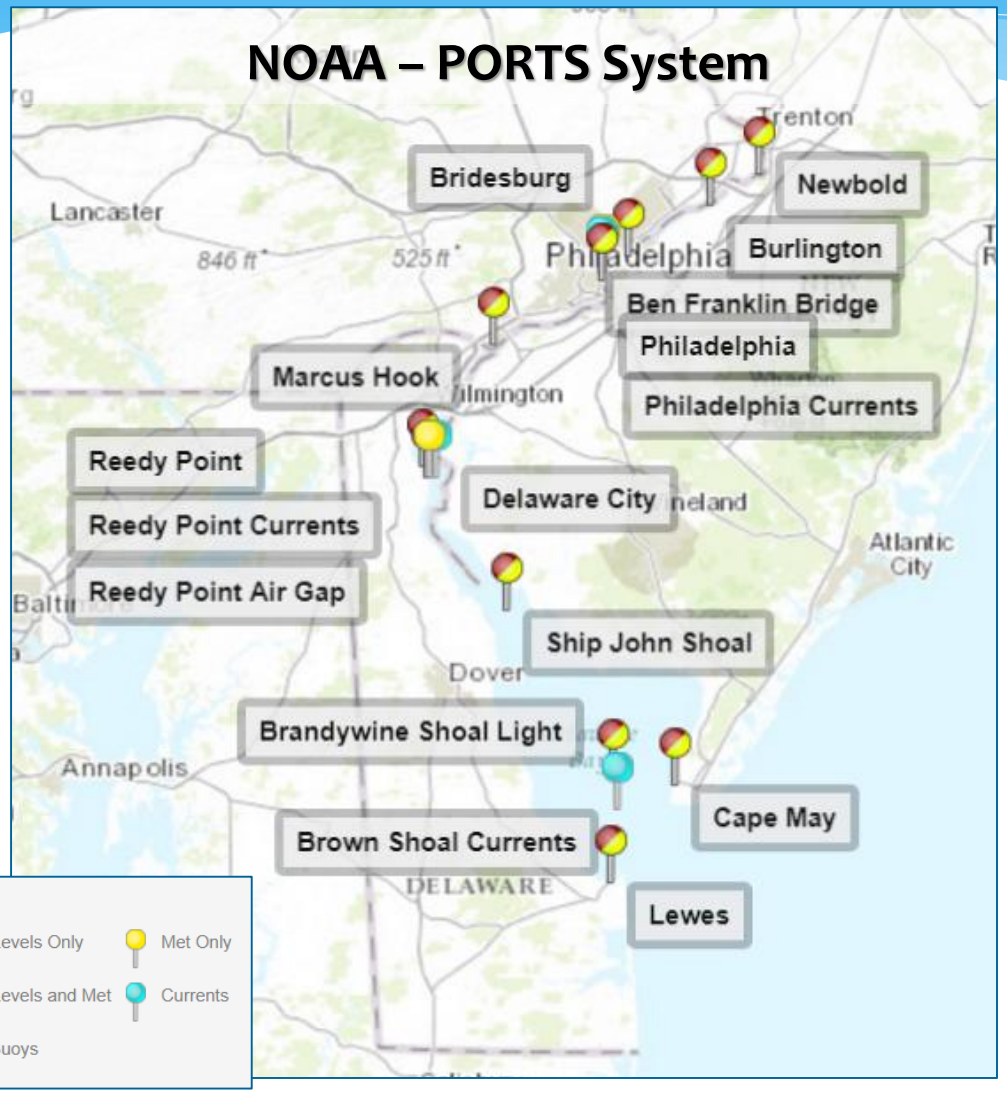
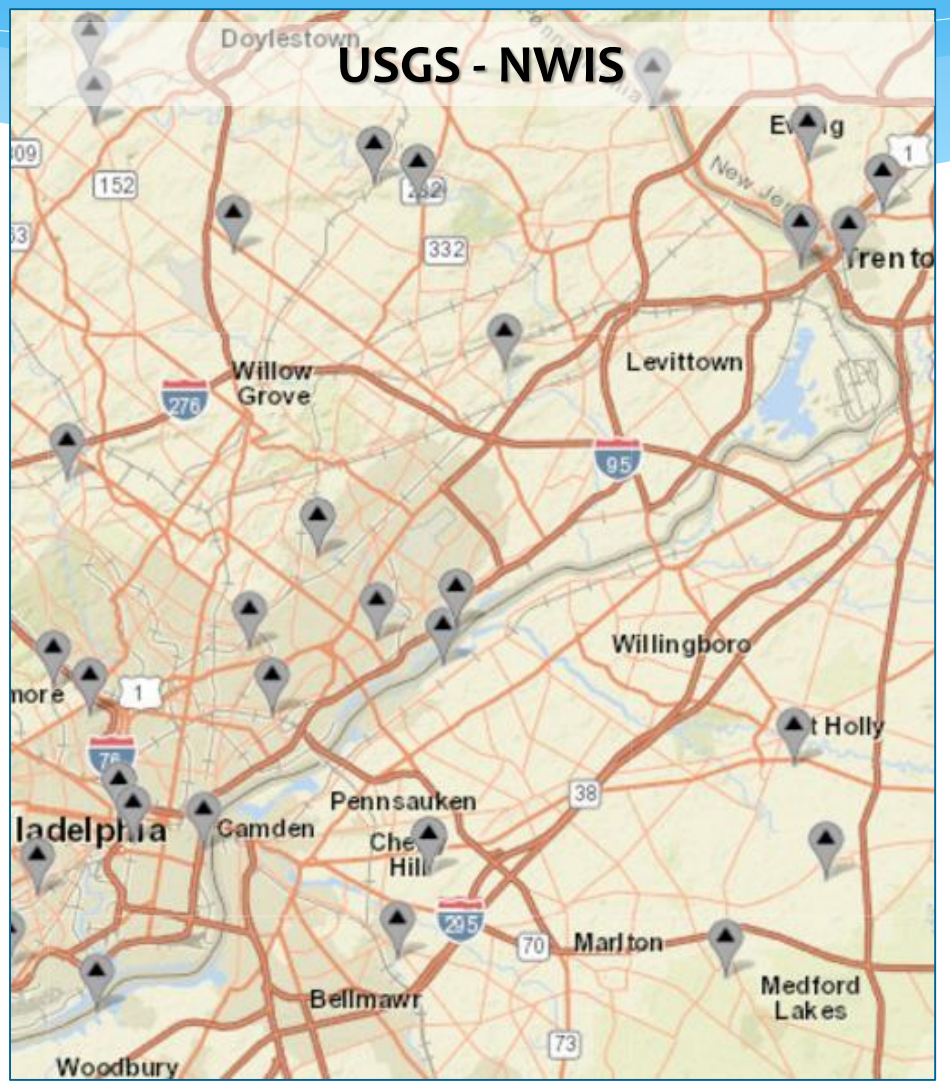
NOAA – PORTS System



USGS - NWIS



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

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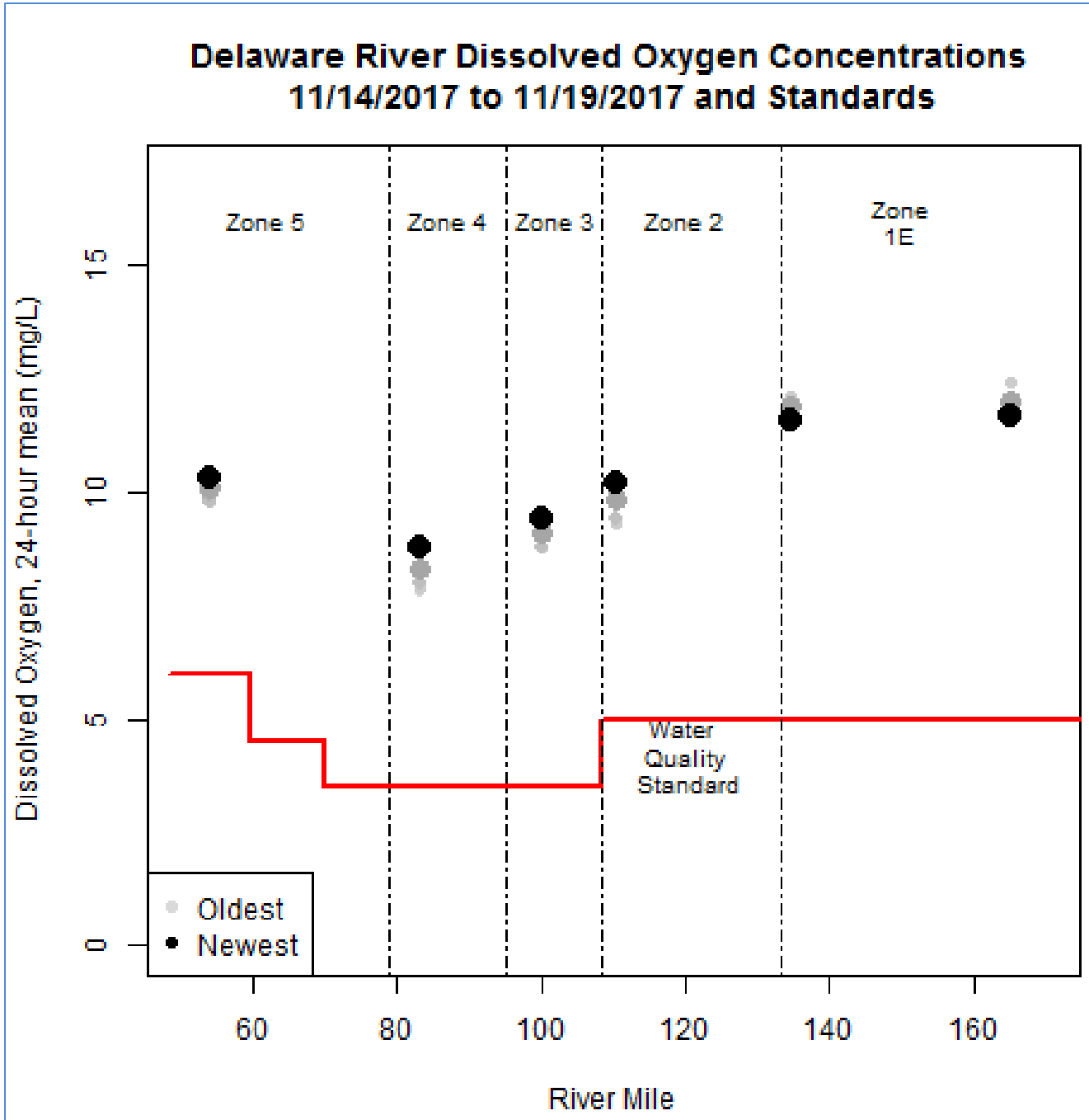

Water Quality Dashboard

* Last 5-days Dissolved Oxygen compared to Criteria

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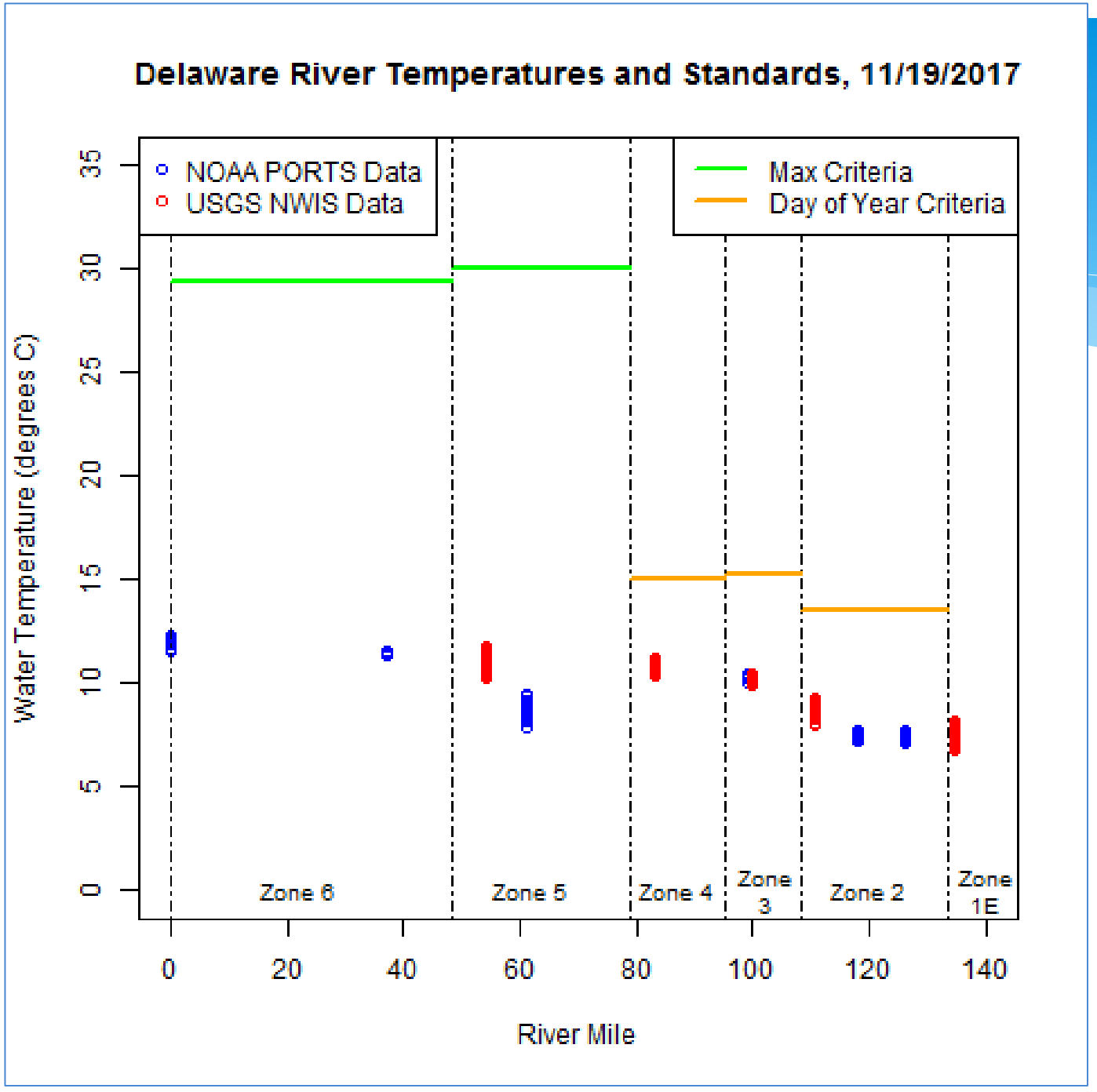

Water Quality Dashboard

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

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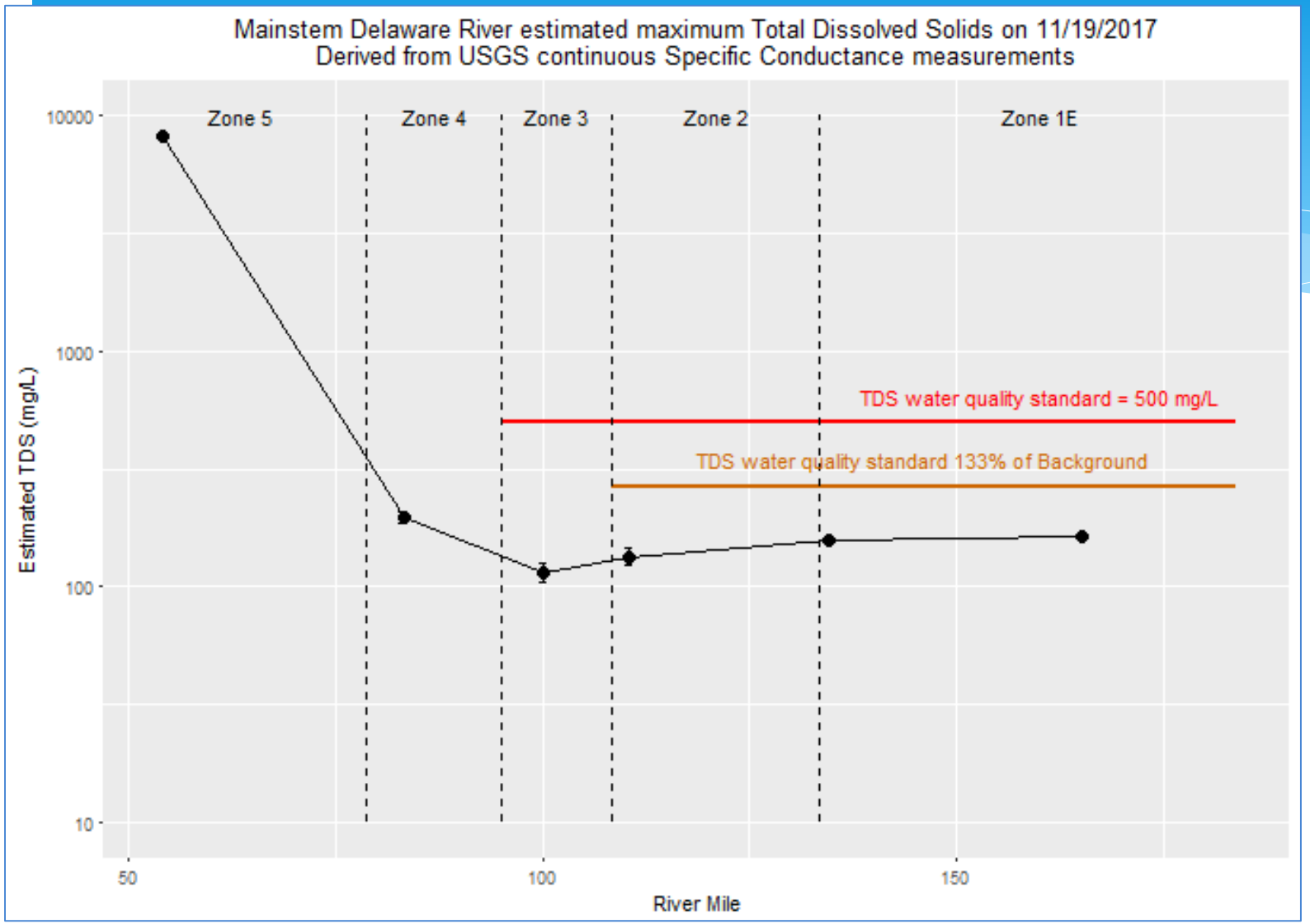
Water Quality Dashboard



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

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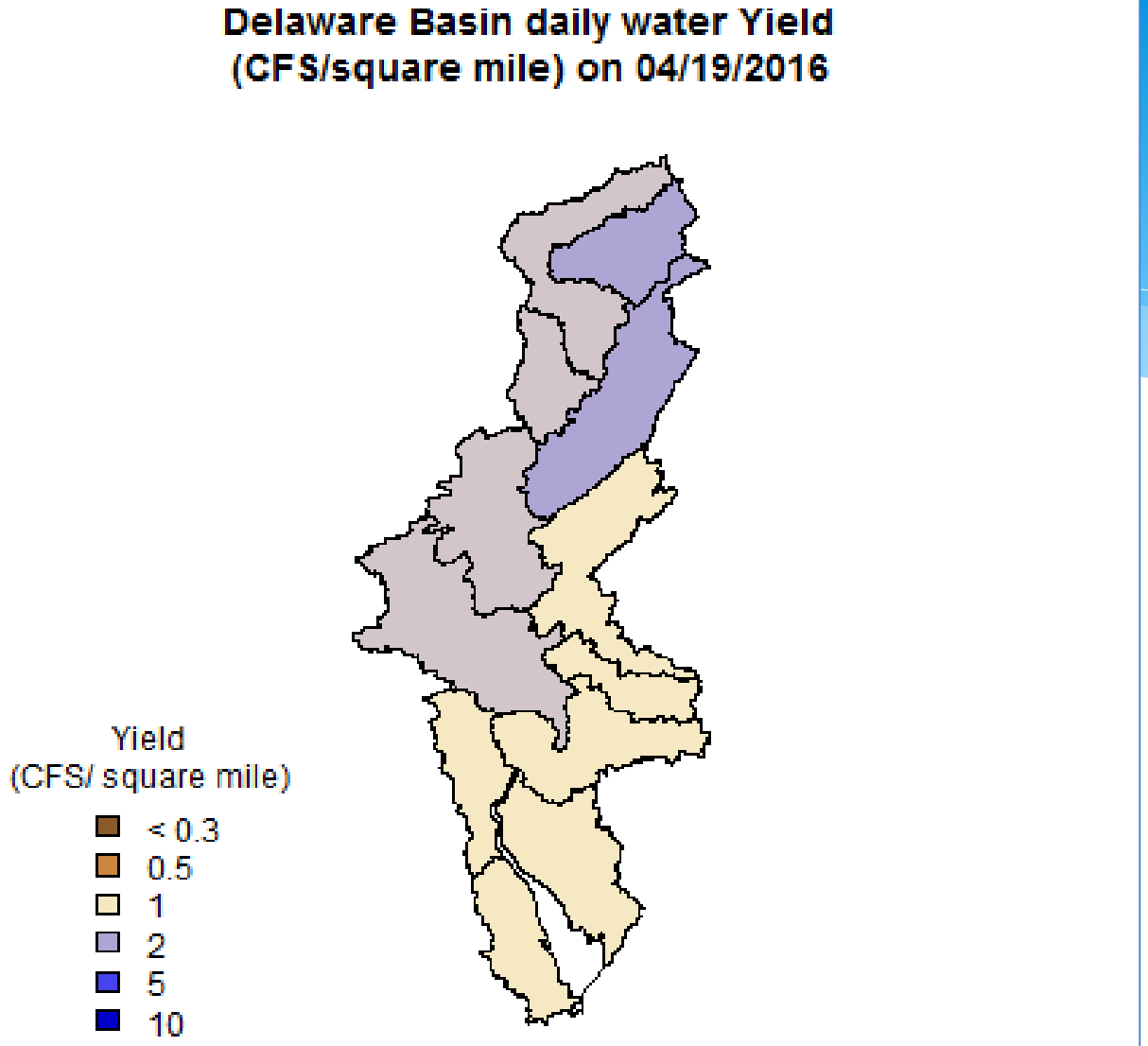

Flow Dashboard

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

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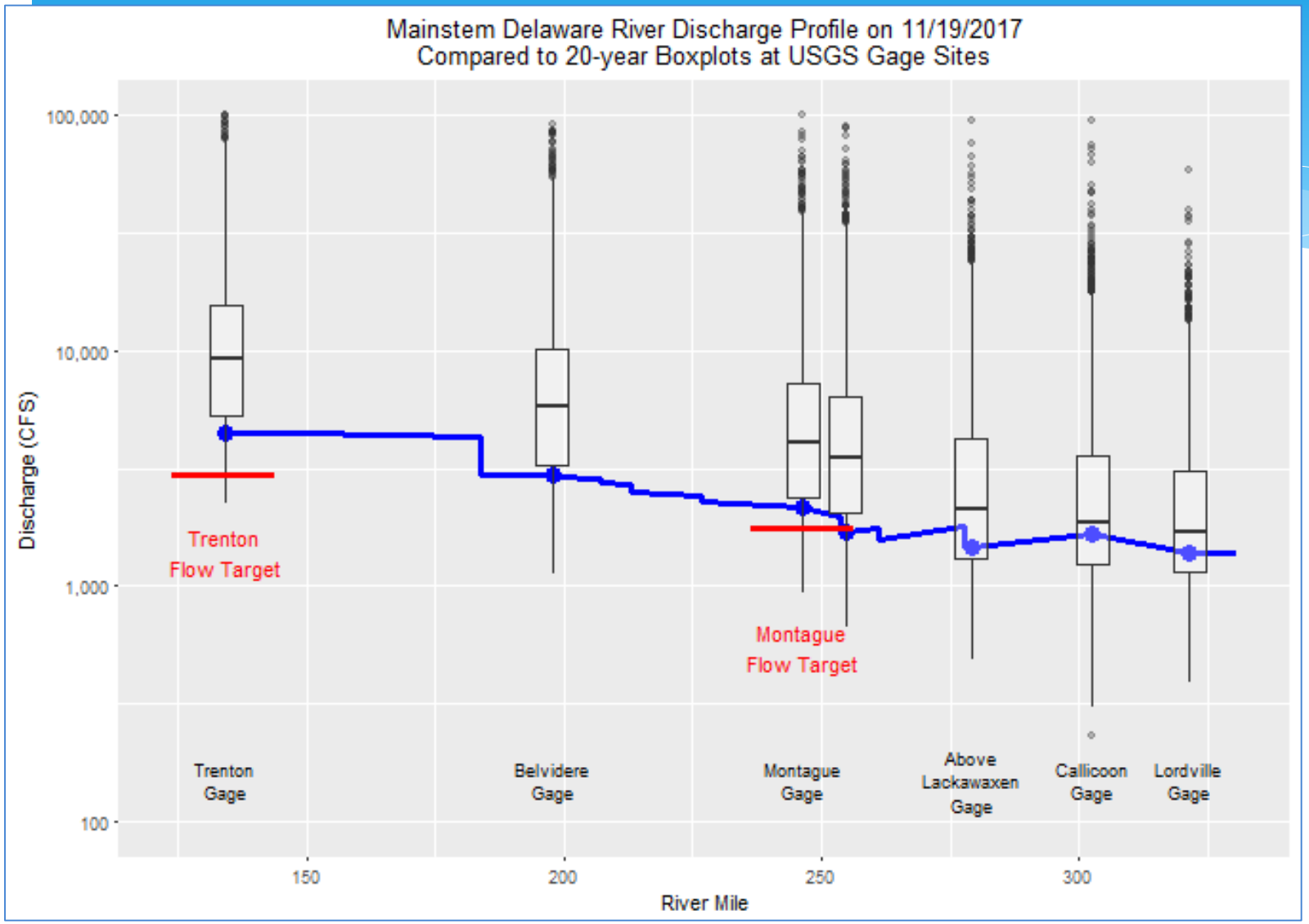
Flow Dashboard



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

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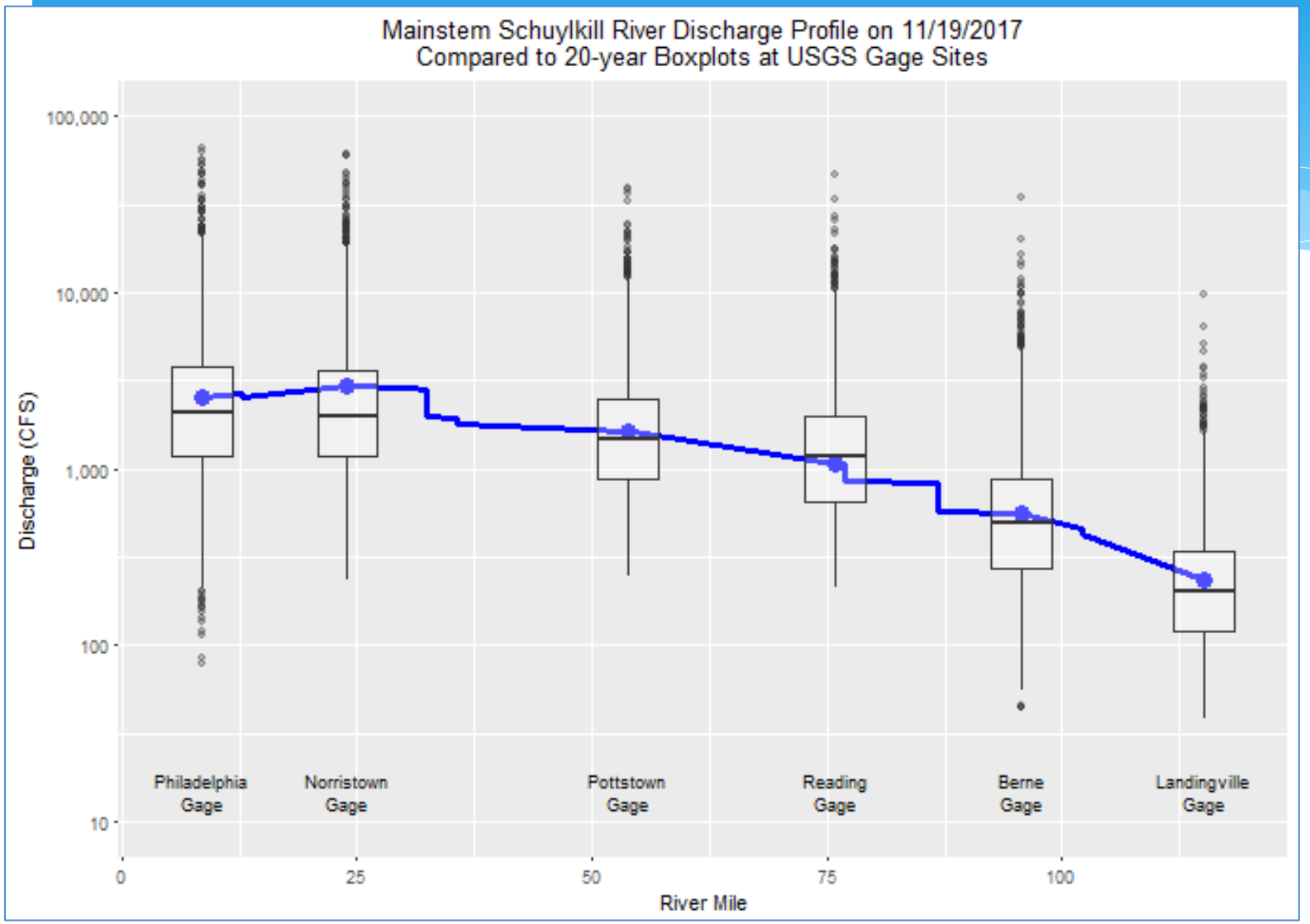
Flow Dashboard



* Same thing for Schuylkill gages

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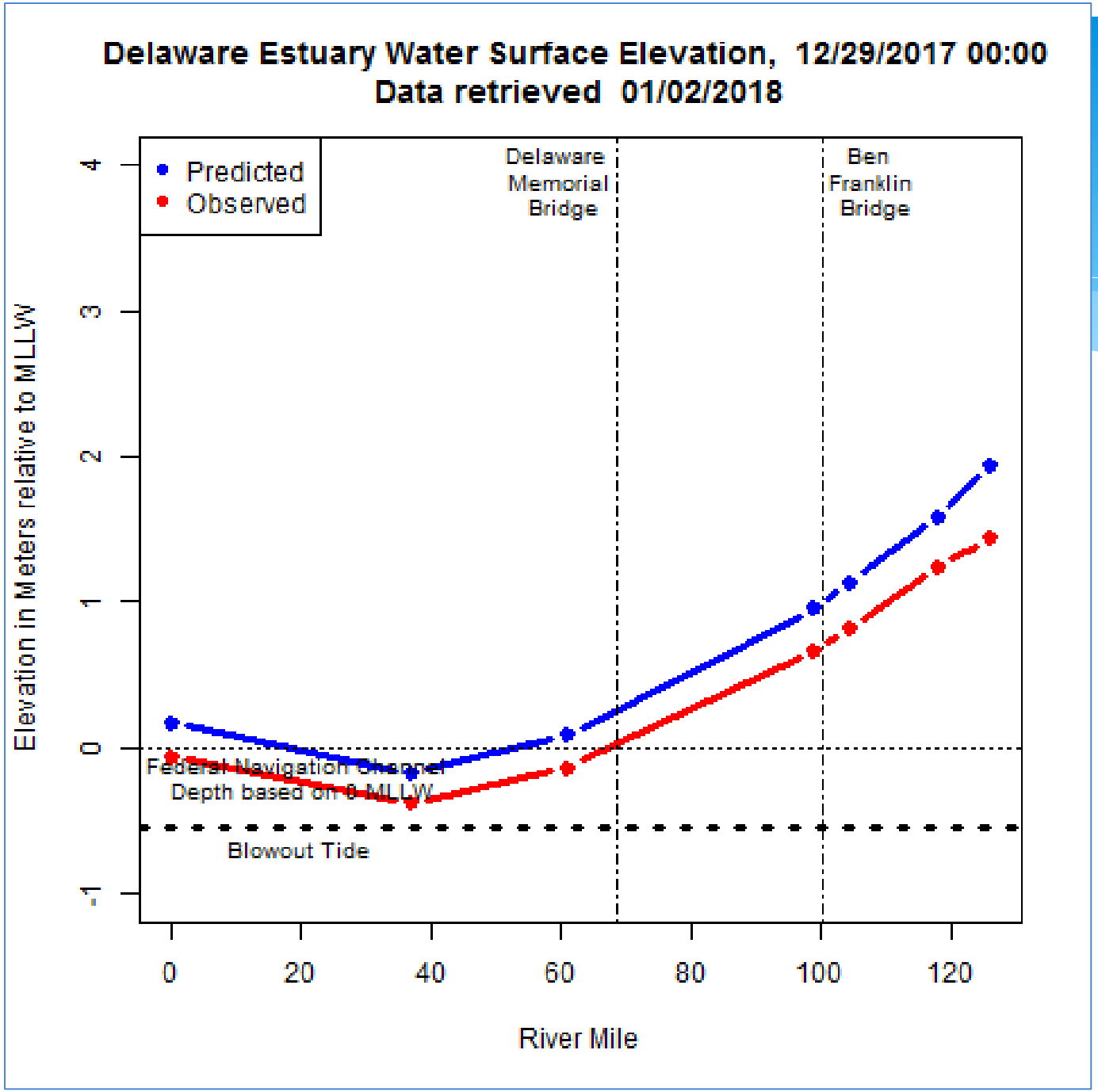
Flow Dashboard



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

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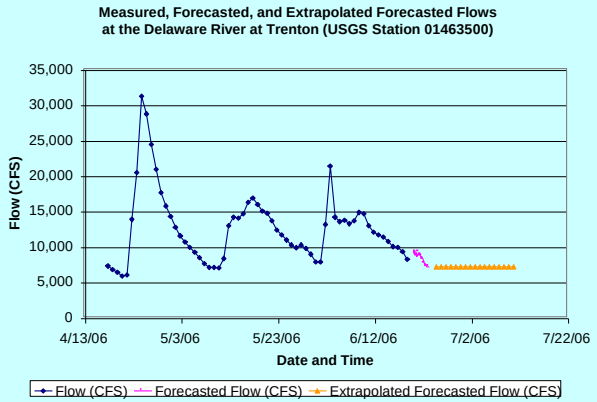
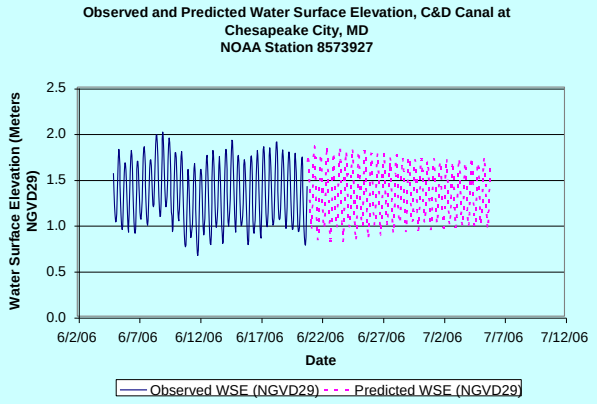
Automated Daily Processes
No User Input Required



Freshwater Boundary Discharge Data and Predictions



Tidal Boundary Water Surface Data and Predictions

Pre-Processor develops model input file

DYNHYD5

Water Quality Simulation in Response to Spill Event

Spill Data

WASP

Predicted Location, Duration, and Concentration of Impacted Water Intakes

Prescriptive Measures to Mitigate Impact

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Using Data Generated by Others: Overnight Hydrodynamic Model

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* 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 DYNYD5 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

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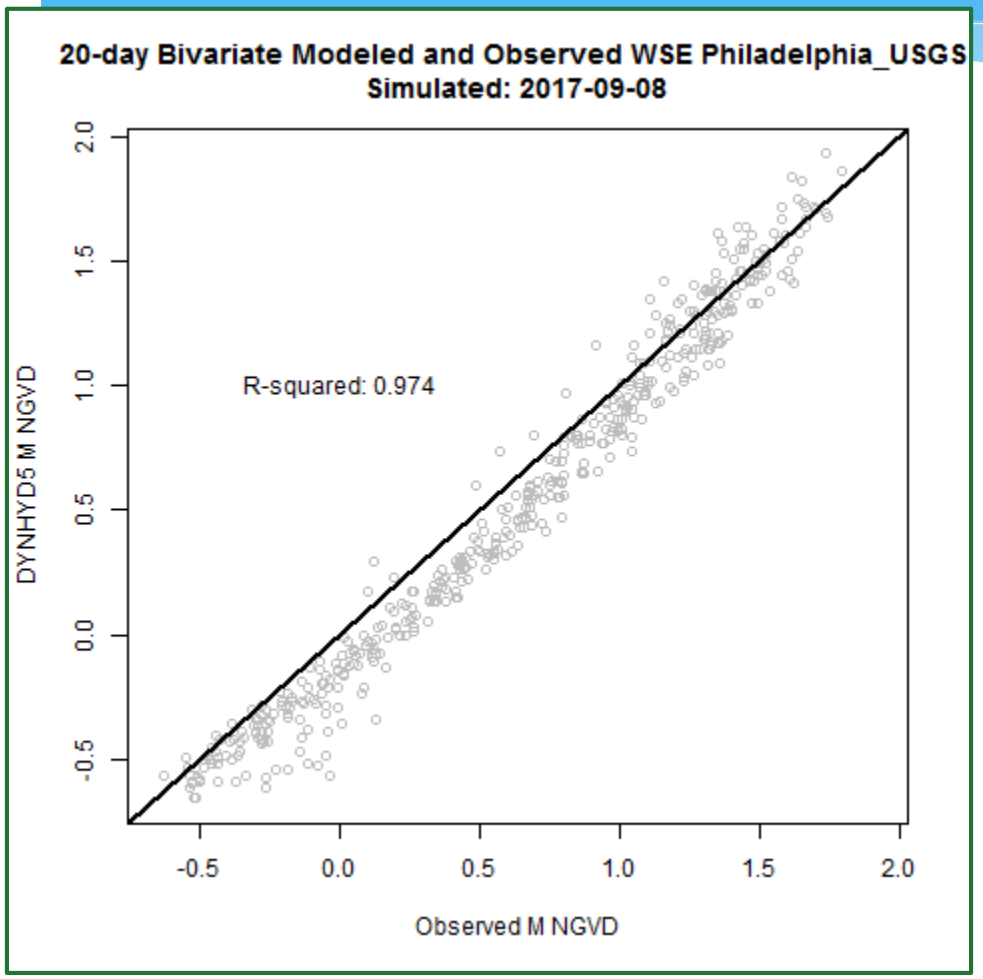
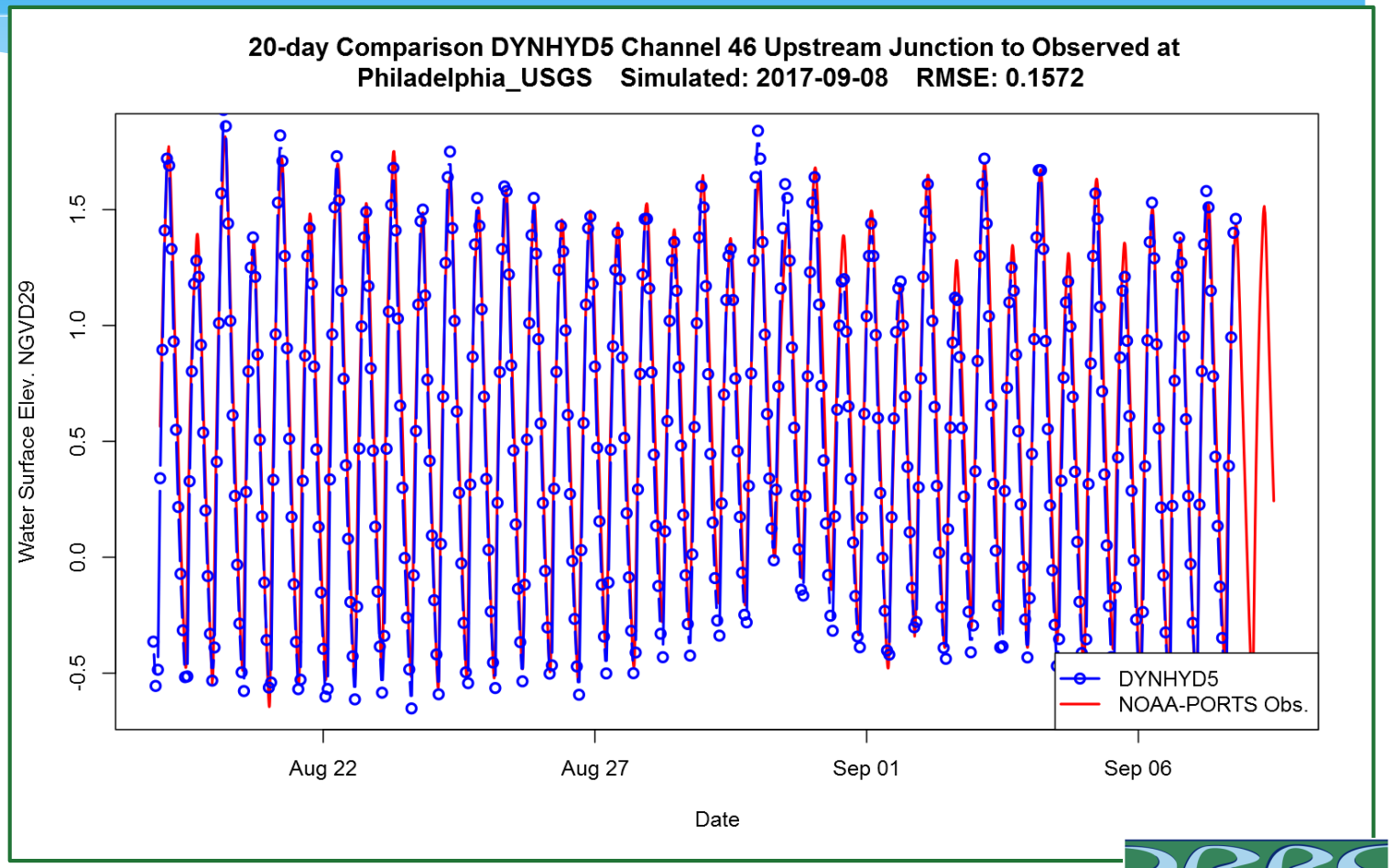
* Earliest version utilized VBA scripts for pulling & processing data
  - http://onlinelibrary.wiley.com/doi/10.1111/jawr.12185/abstract
* From fully automated to mostly automated in 2017 – human interaction is key
* Migrated pulling & processing to R in 2017
* Added daily calibration checks in 2017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

Automated Daily Calibration Checks





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Amplification of Tidal Range

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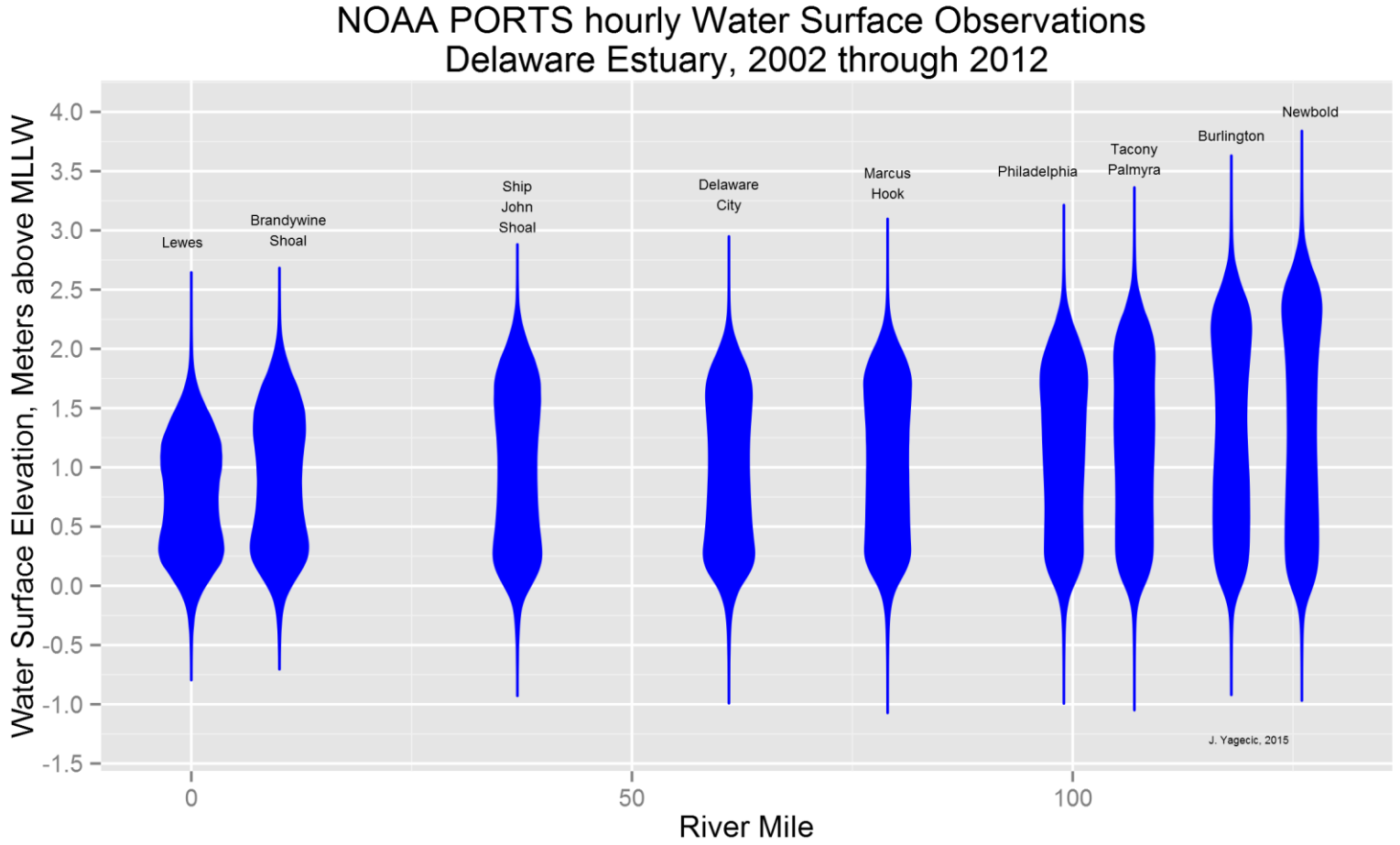
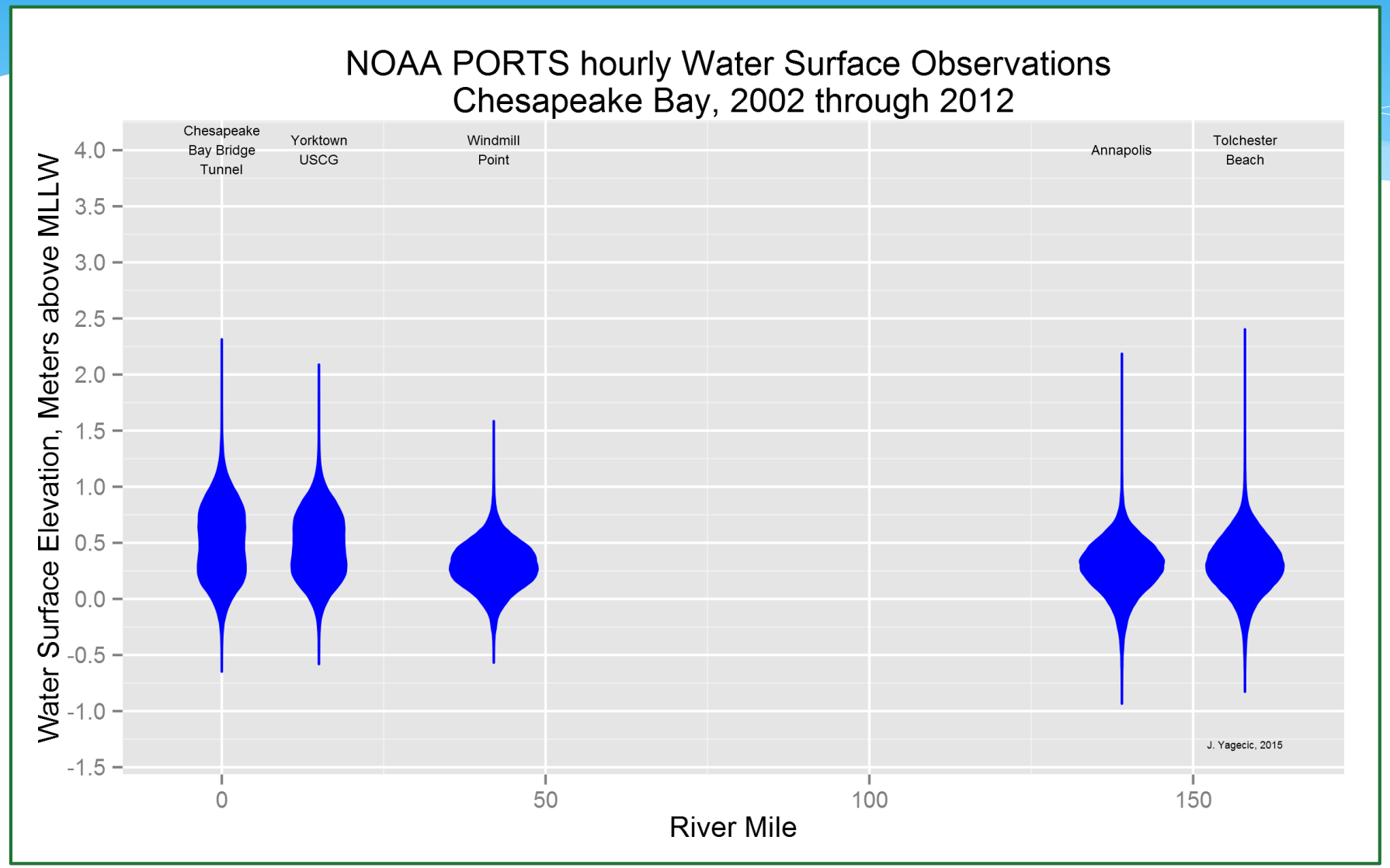


Comparison to Chesapeake



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Orientation to Graph (static)

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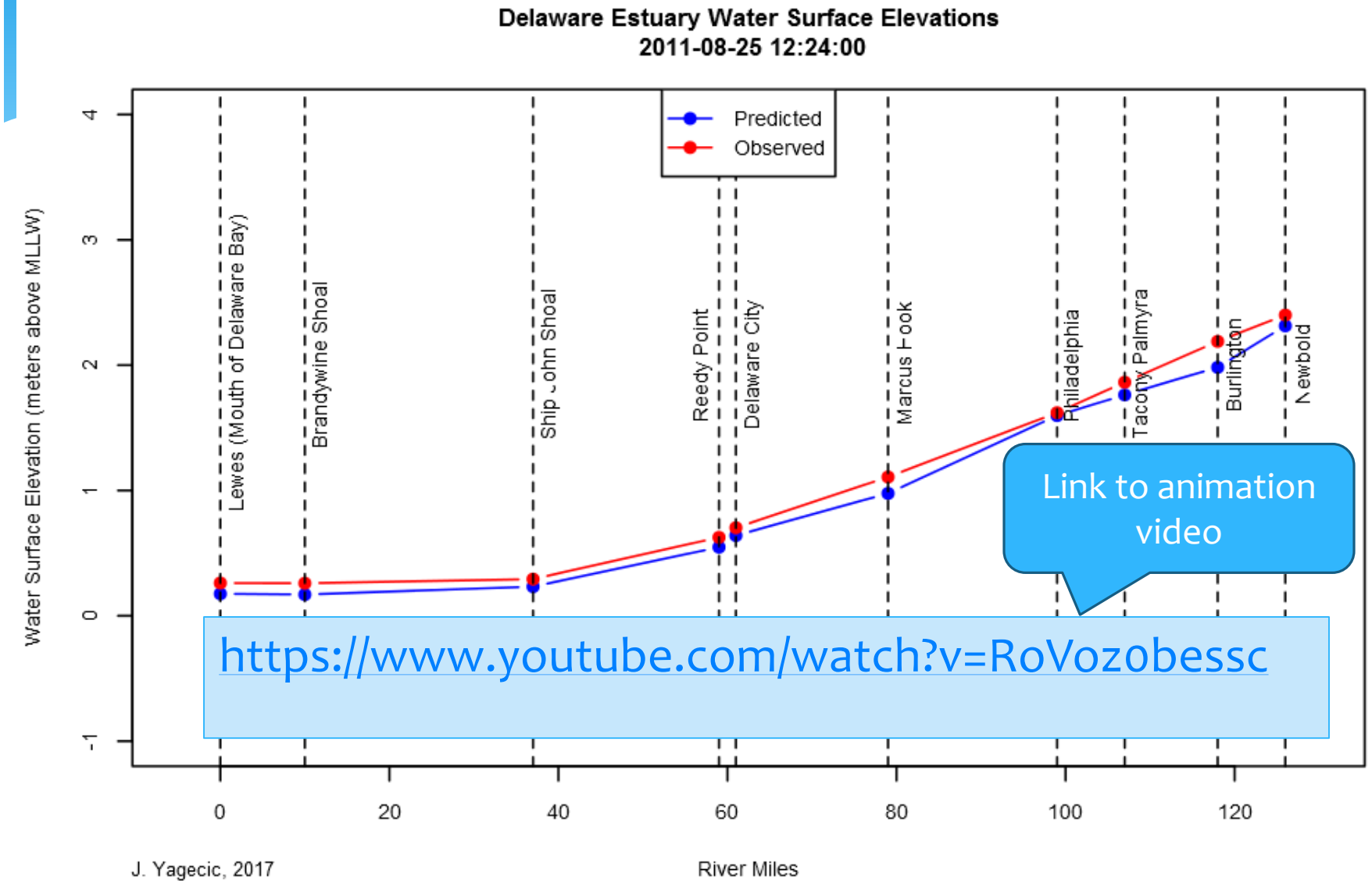
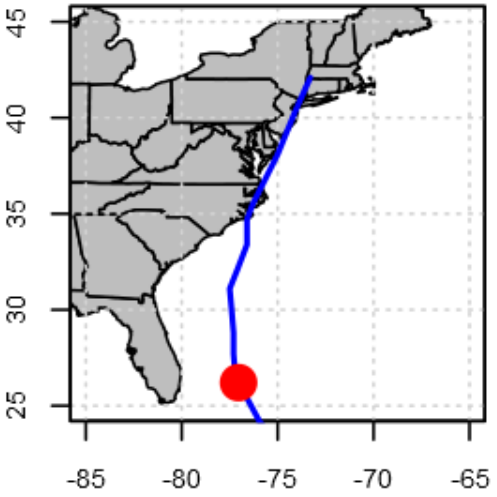
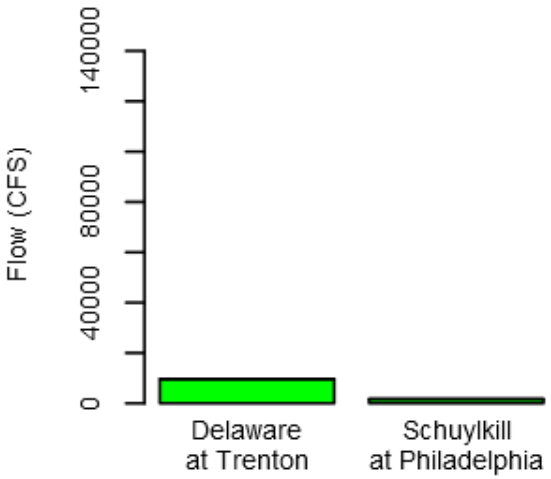


Link to animation video

https://www.youtube.com/watch?v=RoVozobessc









Questions & Discussion

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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!