

Anti-degradation Protection of Water Quality for the Delaware River Basin: Expansion of the Control Point Approach to Monitoring and Assessment

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National Wild and Scenic Reaches in the Delaware River Basin

Special Protection Waters (SPW) Policy: “No measurable change to Existing Water Quality (EWQ) unless due to natural conditions”

SPW rules cover $\approx 6,780$ of the 13,800 sq. mi. Delaware River Basin watershed area

Monitored by the DRBC/NPS Scenic Rivers Monitoring Program (SRMP)



SRMP Upper Delaware (UPDE) Sites

1992 Designated Outstanding Basin Waters (CWA Tier 3)

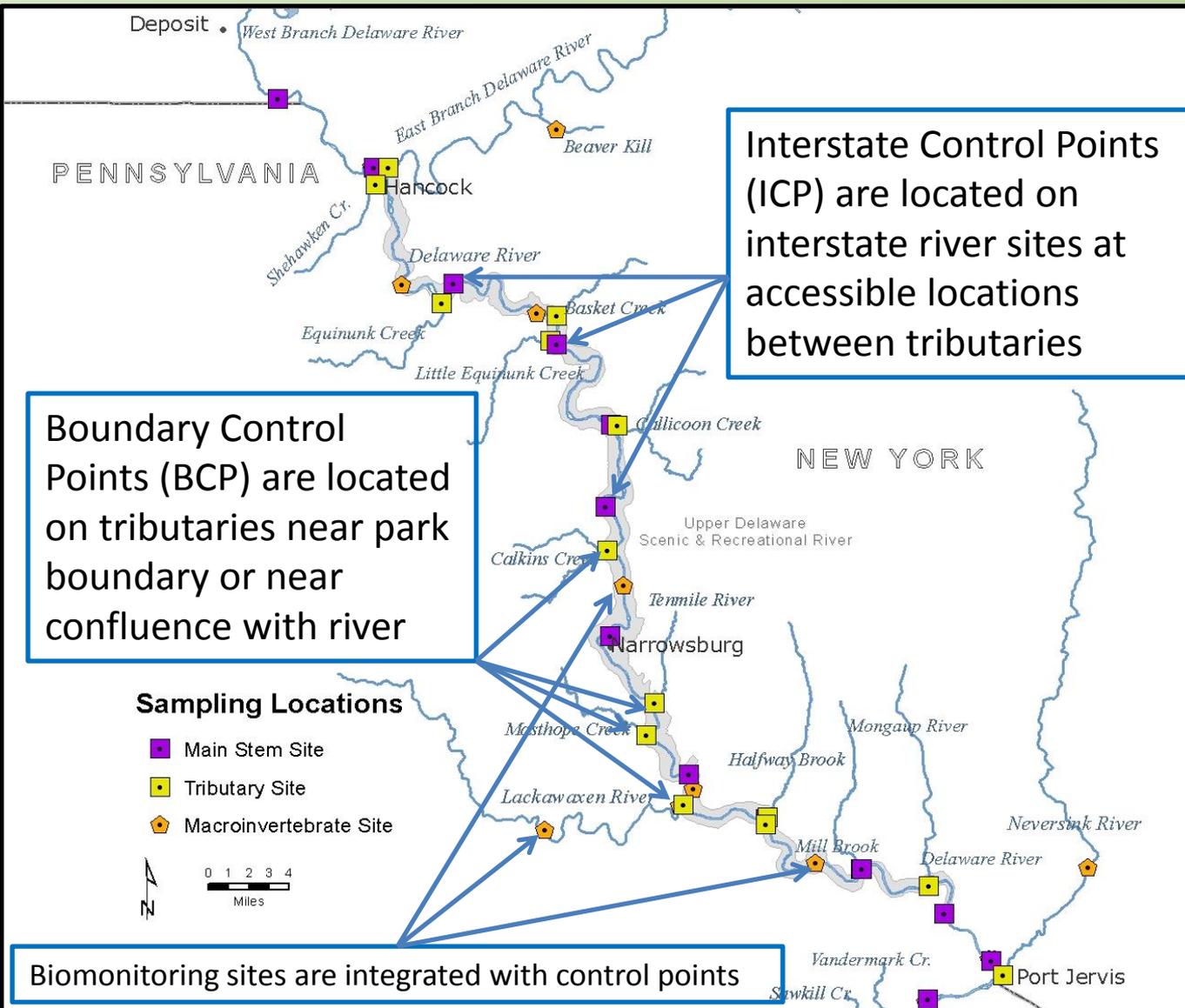
Control Point approach to monitoring arose from:

Narrow shape of park boundaries;

DRBC river-centric jurisdictional responsibilities;

Direct applicability to QUAL2K modeling for permits;

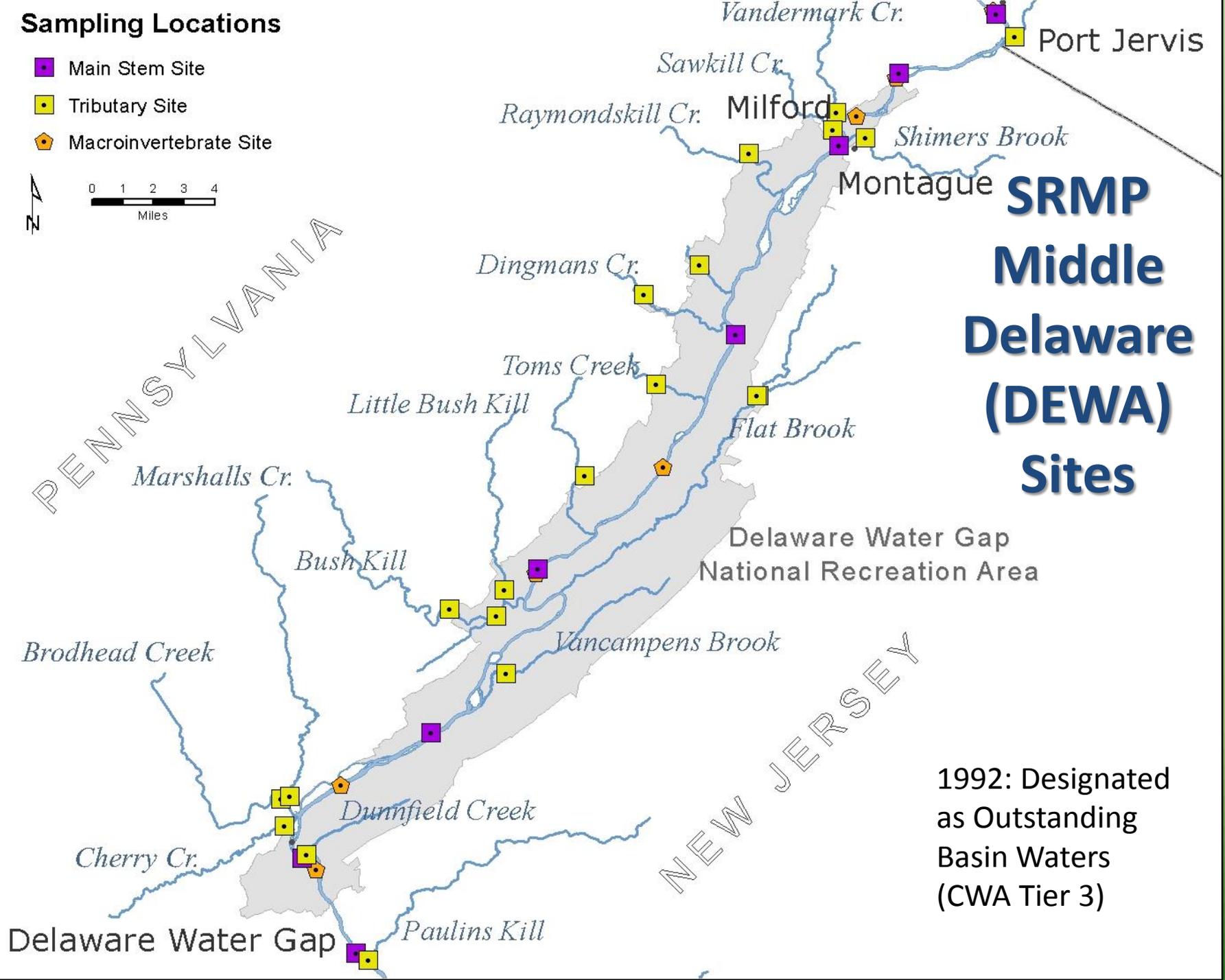
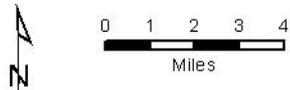
Tracking water quality down a 200+ mile longitudinal corridor



Think of this design as a very long series of upstream/downstream studies

Sampling Locations

- Main Stem Site
- Tributary Site
- Macroinvertebrate Site



SRMP Middle Delaware (DEWA) Sites

1992: Designated
as Outstanding
Basin Waters
(CWA Tier 3)

Conversion of UPDE and DEWA Existing Water Quality from Reach-Wide (1992) to Site-Specific (2011) – WHY?

- **Breidt et. al. (1989)***
 - Statistically analyzed EWQ for NPS and DRBC
 - Saw differences between sites within regulatory reaches
 - Did not advocate reach-wide targets (ignored...)
 - Recommended non-parametric approach (ignored...)
 - Reach-wide targets were kept in rules for simplicity & to avoid delays
- **Lower Delaware 2000-2004 EWQ definition project followed Breidt et. al. approach; are non-parametric and site-specific; and have worked well for project review and assessment tasks.**
- **Assessment task was not possible 1992-2013 in UPDE and DEWA using reach-wide targets; Parent data were unrecoverable, unevenly sampled within reaches, and contained replacement values for non-detect measurements at relatively high MDL's. Back-conversion of log-transformed geometric means' confidence limits created artificially tight anti-degradation targets. Since geometric mean approximates the median, it is better to simply use median.**

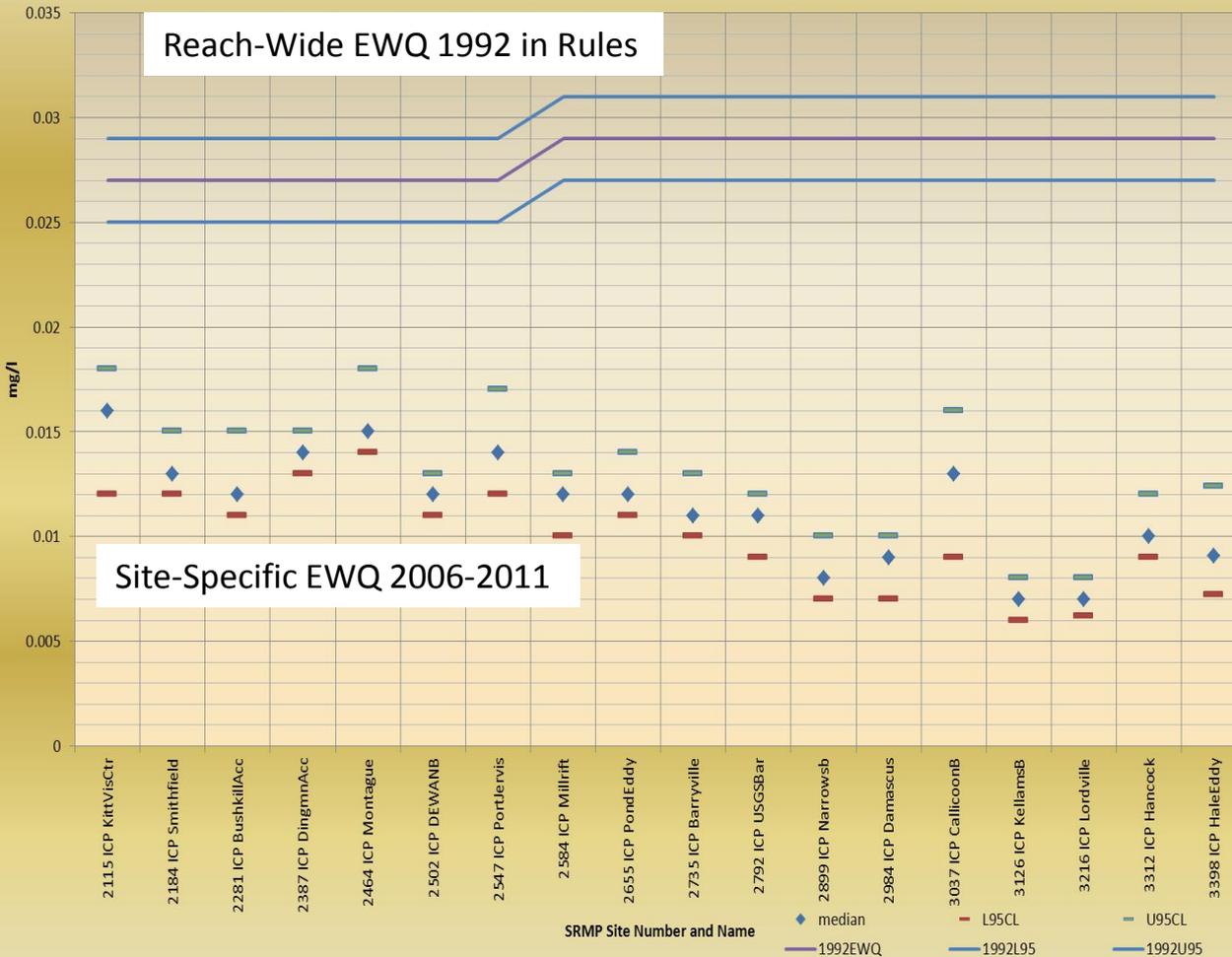
* Breidt, F.J., D.C. Boes, J.I. Wagner, and M.D. Flora. 1991. Antidegradation water quality criteria for the Delaware River: a distribution-free statistical approach. Water Resources Bulletin 27(5): 849-858.

Purposes for EWQ Targets

- Project Review and Permitting Waste-Water Treatment Facilities
 - use upper 95% confidence limits of median concentrations of Ammonia, DO, Fecal Coliform, Nitrate + Nitrite, Total Phosphorus, TKN, TSS for design of treatment facilities to prevent water quality degradation.
- Monitoring and Assessment of Measurable Change to EWQ:
 - Create site-specific and representative baseline (4-5 years, n approx. 50)
 - Statistically compare subsequent Assessment Rounds (3-5 years, n = 30 to 50) to baseline set.
- Review & quantify measurable changes and feed back to permitters and planners, work with states, municipalities and NGO's to solve potential problems before water quality degrades (\$\$), instead of TMDL's after criteria are violated (\$\$\$\$\$\$.....).
- Demonstrated success in Neversink Watershed, NY (rept. in progr.)

UPDE and DEWA EWQ: Reach-Wide 1992 vs. Site Specific 2011

Existing Water Quality by River Mile: Phosphorus as P, Total (TP) mg/l



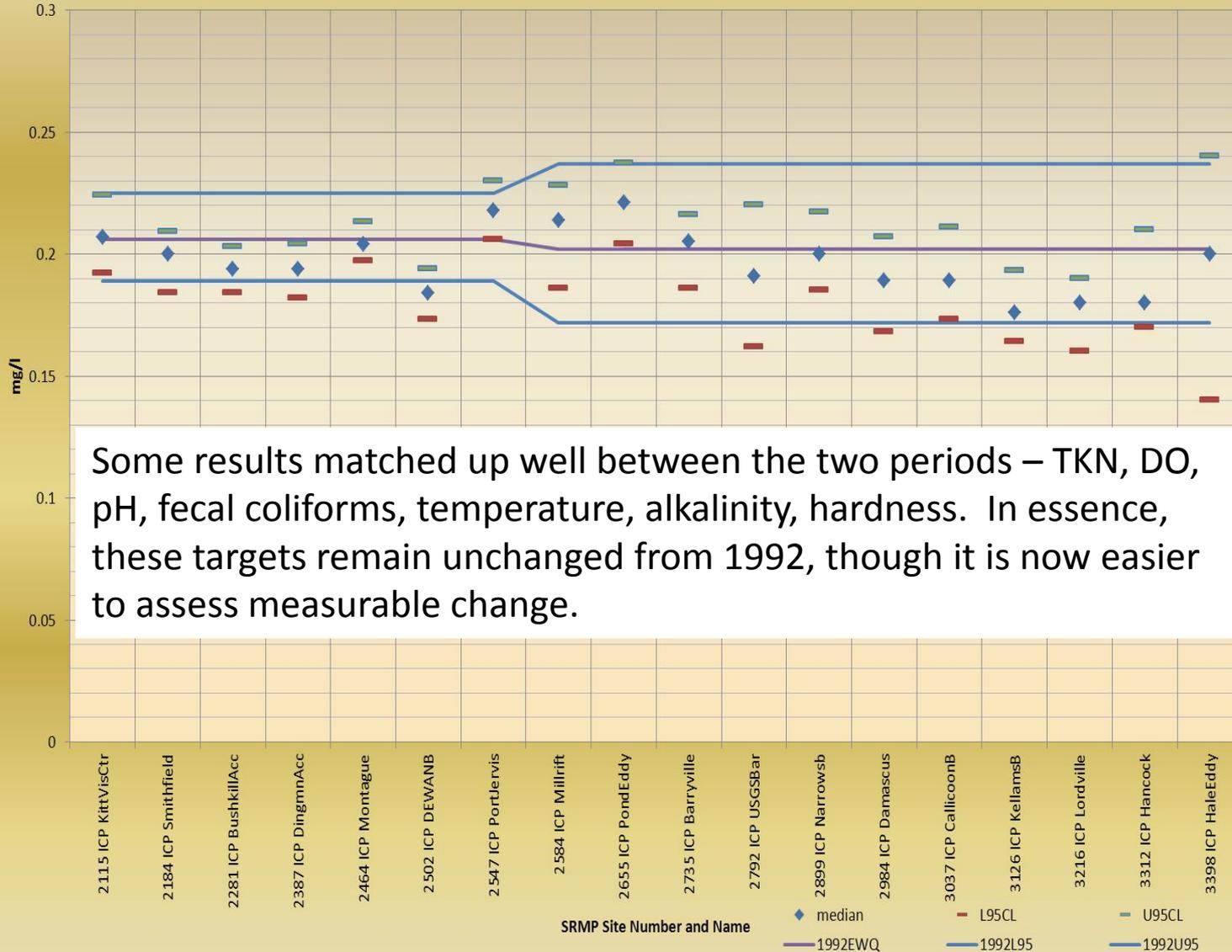
Less Confidence, hard to assess changes, uneven geographic distribution of data

Improved Confidence, easy to assess changes within and between sites, all data adhere to program objectives

Many concentrations were much reduced since 1992, including most nutrients. Probable explanations: improved MDL's; abandoning use of replacement values for non-detects and forcing normality of distributions mathematically; but it is possible that water quality also simply improved. Policy implications of adoption of "new" targets have not yet been addressed.

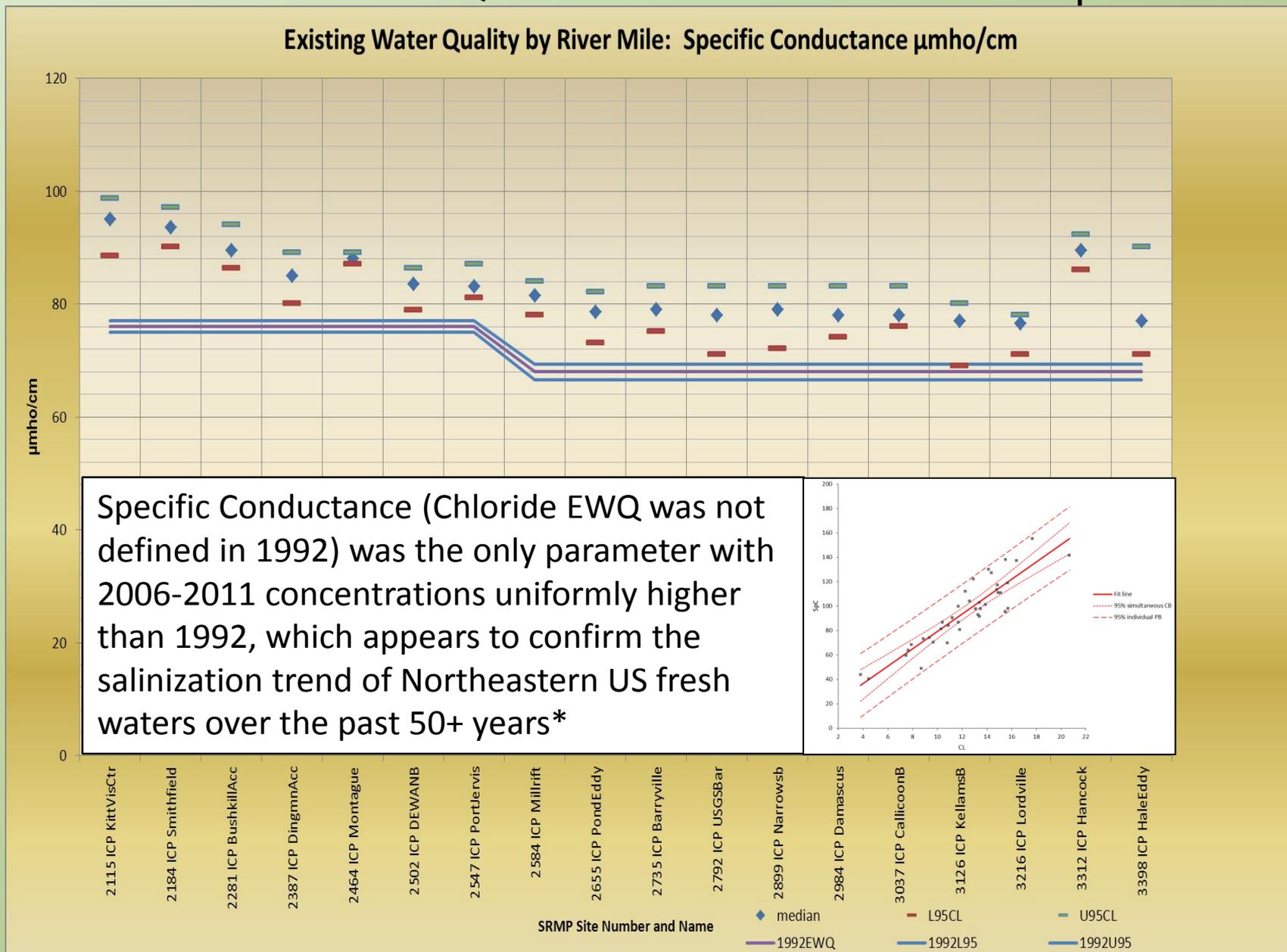
UPDE and DEWA EWQ: Reach-Wide 1992 vs. Site Specific 2011

Existing Water Quality by River Mile: Nitrogen, Kjeldahl as N, Total (TKN) mg/l



Some results matched up well between the two periods – TKN, DO, pH, fecal coliforms, temperature, alkalinity, hardness. In essence, these targets remain unchanged from 1992, though it is now easier to assess measurable change.

UPDE and DEWA EWQ: Reach-Wide 1992 vs. Site Specific 2011



*Kaushal et. al. 2005. Increased salinization of fresh water in the northeastern United States. Proc. Nat. Acad. Sci. 102 (38): 13517-13520

USING THE CONTROL POINT APPROACH TO MONITOR AND MANAGE TEMPORALLY, SPATIALLY, AND IN CONSIDERATION OF FLOW

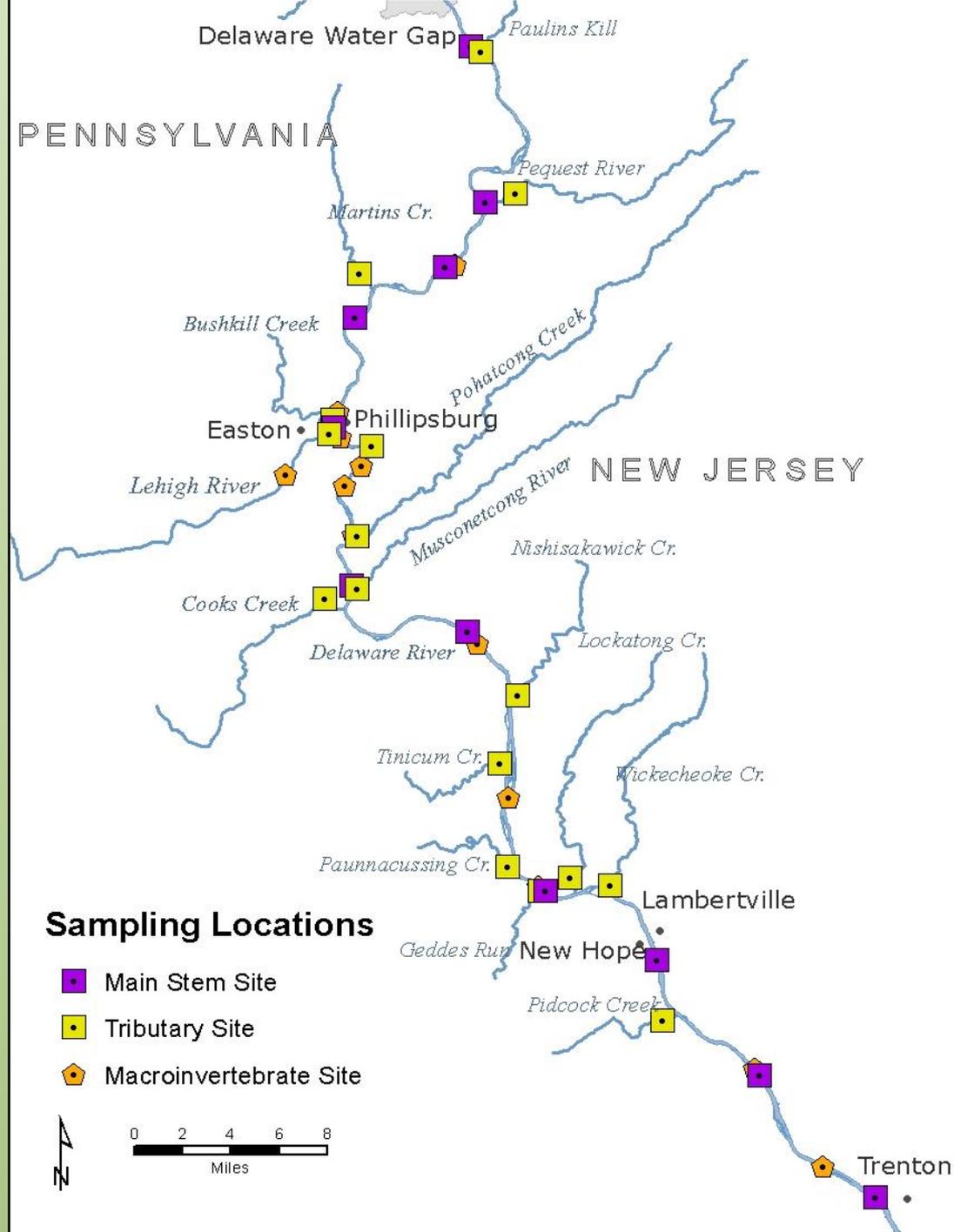
SRMP Lower Delaware (LDEL) Sites

EWQ established 2000-2004

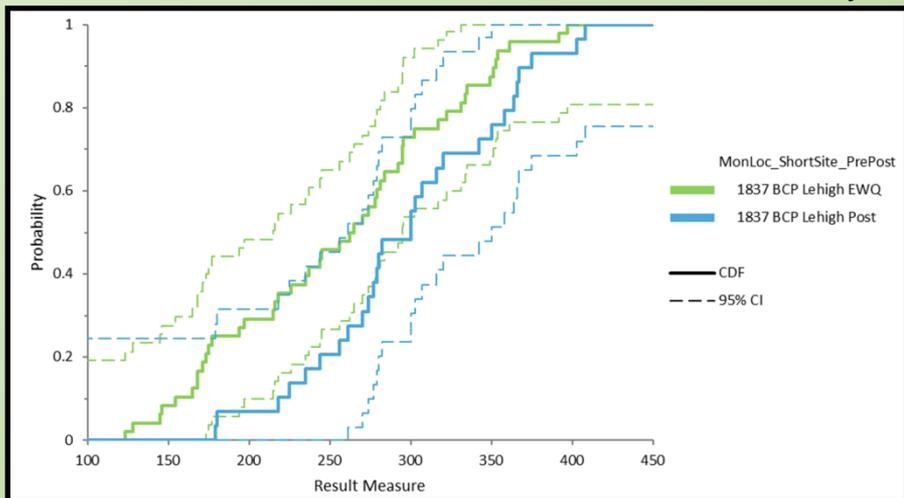
SPW Rules 2007

Designated as Significant
Resource Waters (CWA Tier 2)

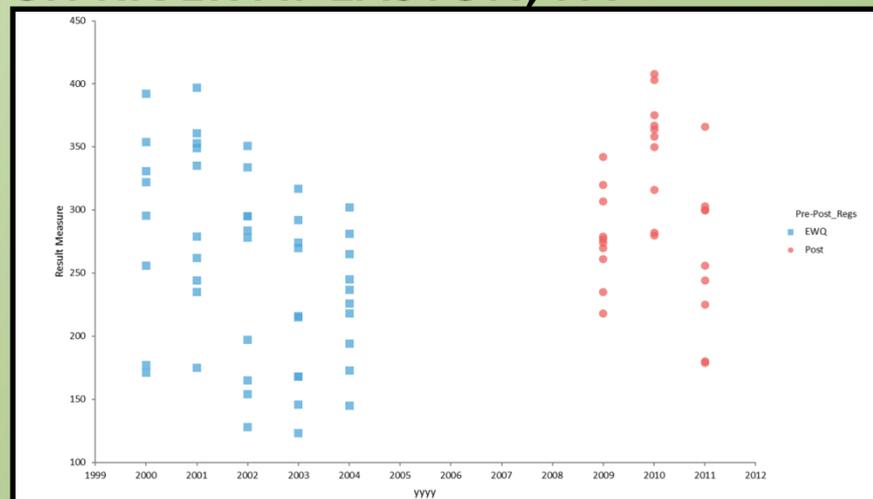
Assessment 1 2009-2011



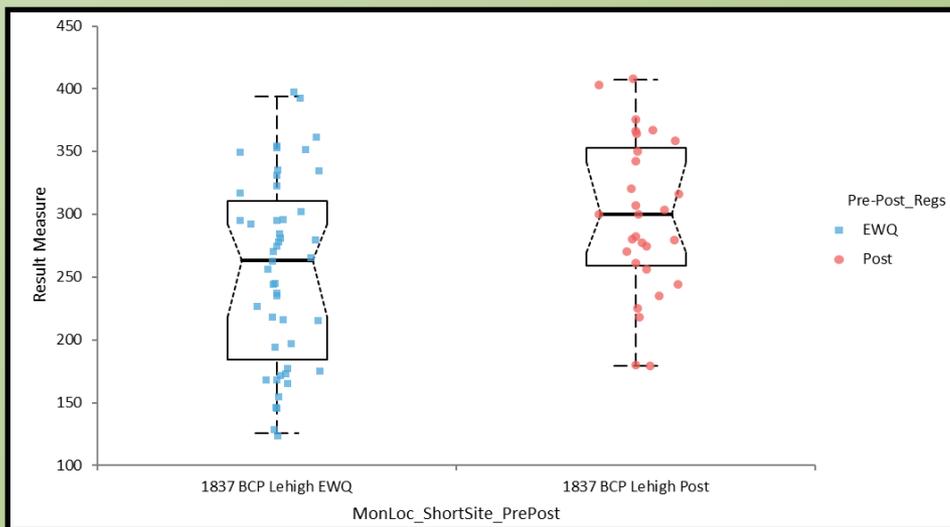
WITHIN SITE PRE/POST COMPARISONS, VIEWING THE DATA: SPECIFIC CONDUCTANCE, LEHIGH RIVER AT EASTON, PA



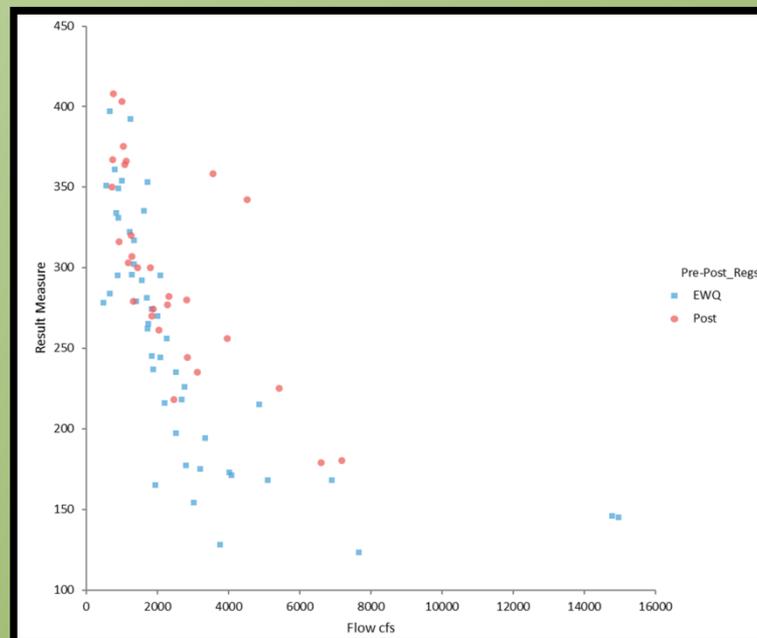
Cumulative Distribution Functions



Annual Plots

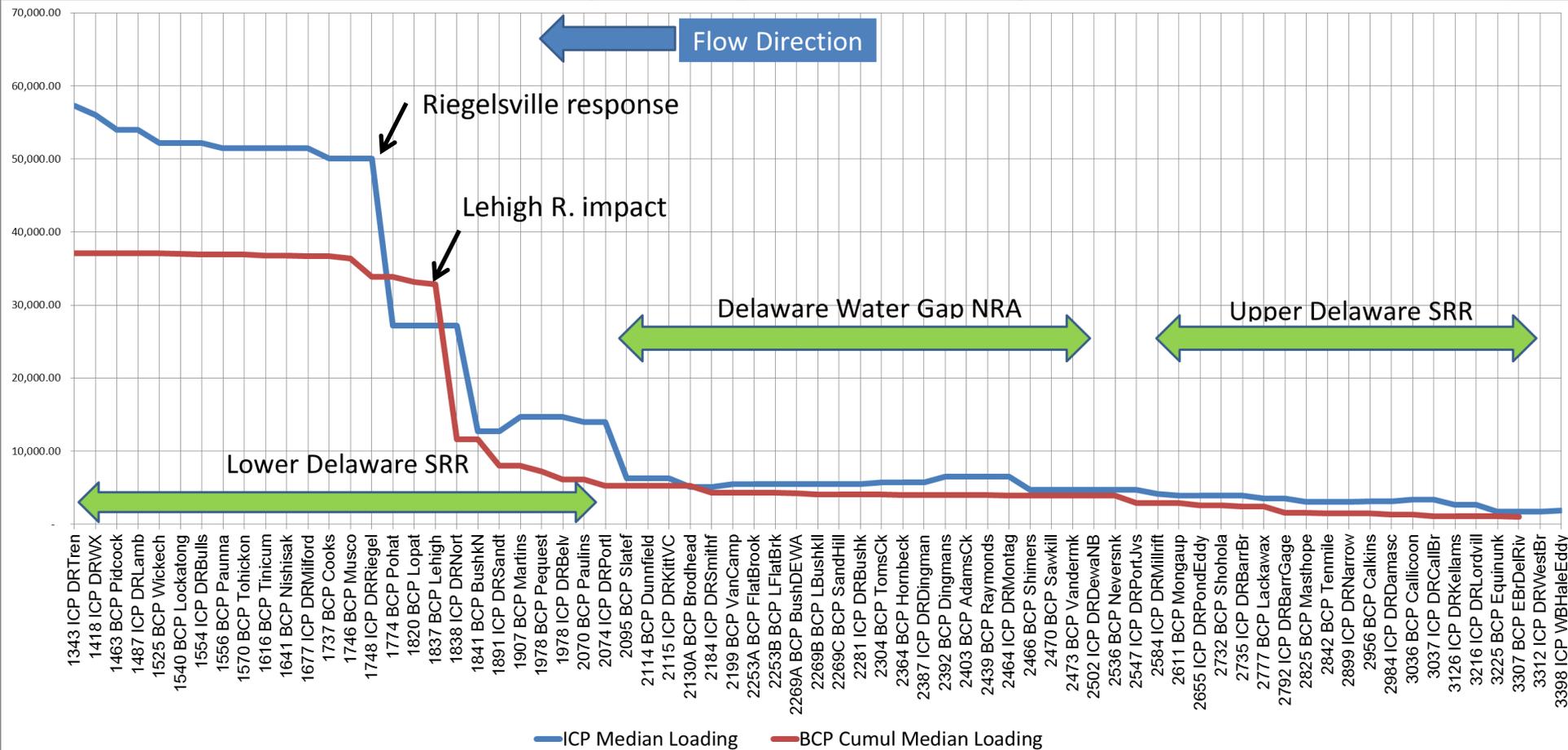


Box Plots & Kruskal-Wallis Tests



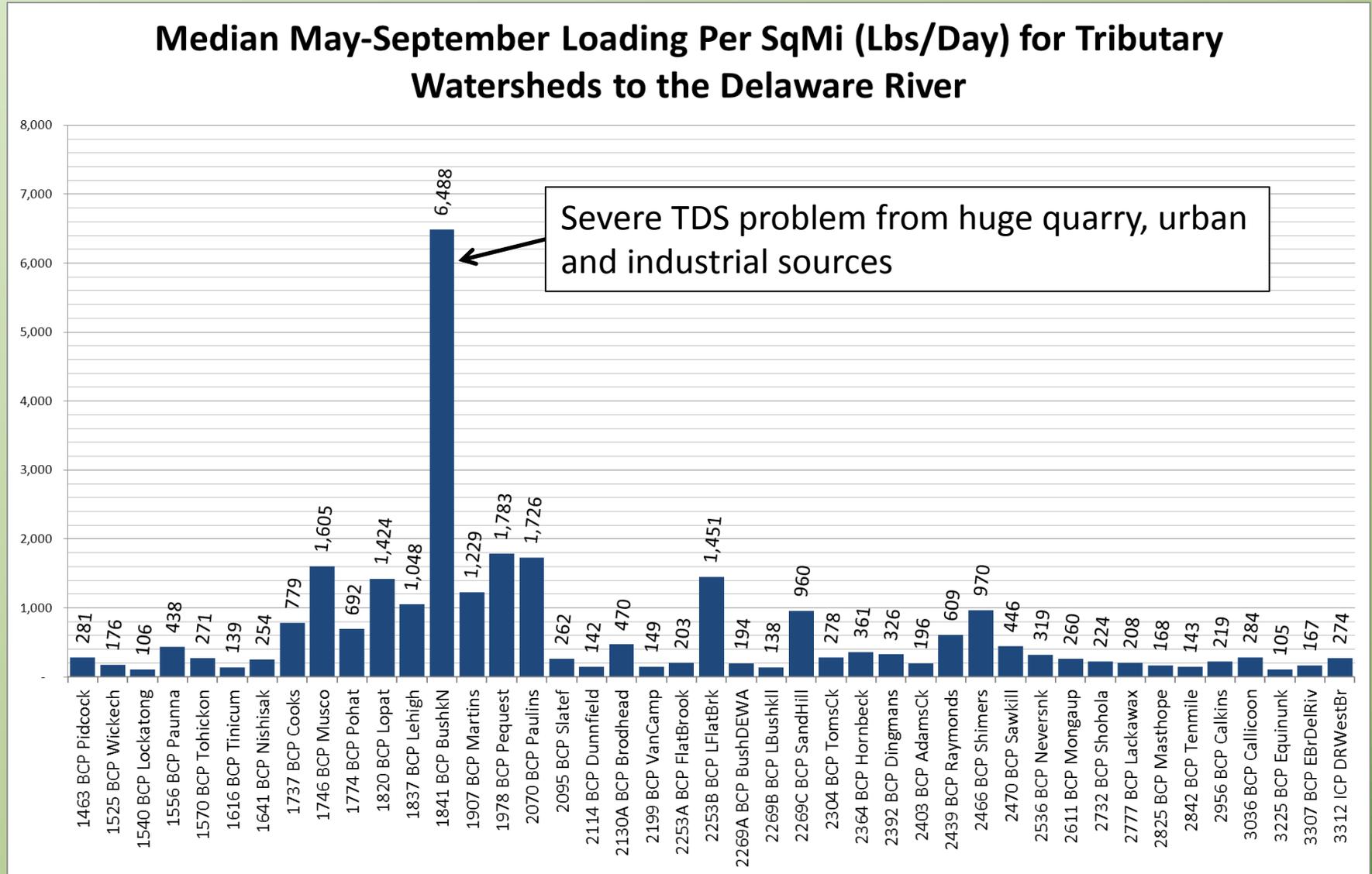
Versus Flow

Other Data Views: Longitudinal Loadings Plots (no Pre/Post shown)



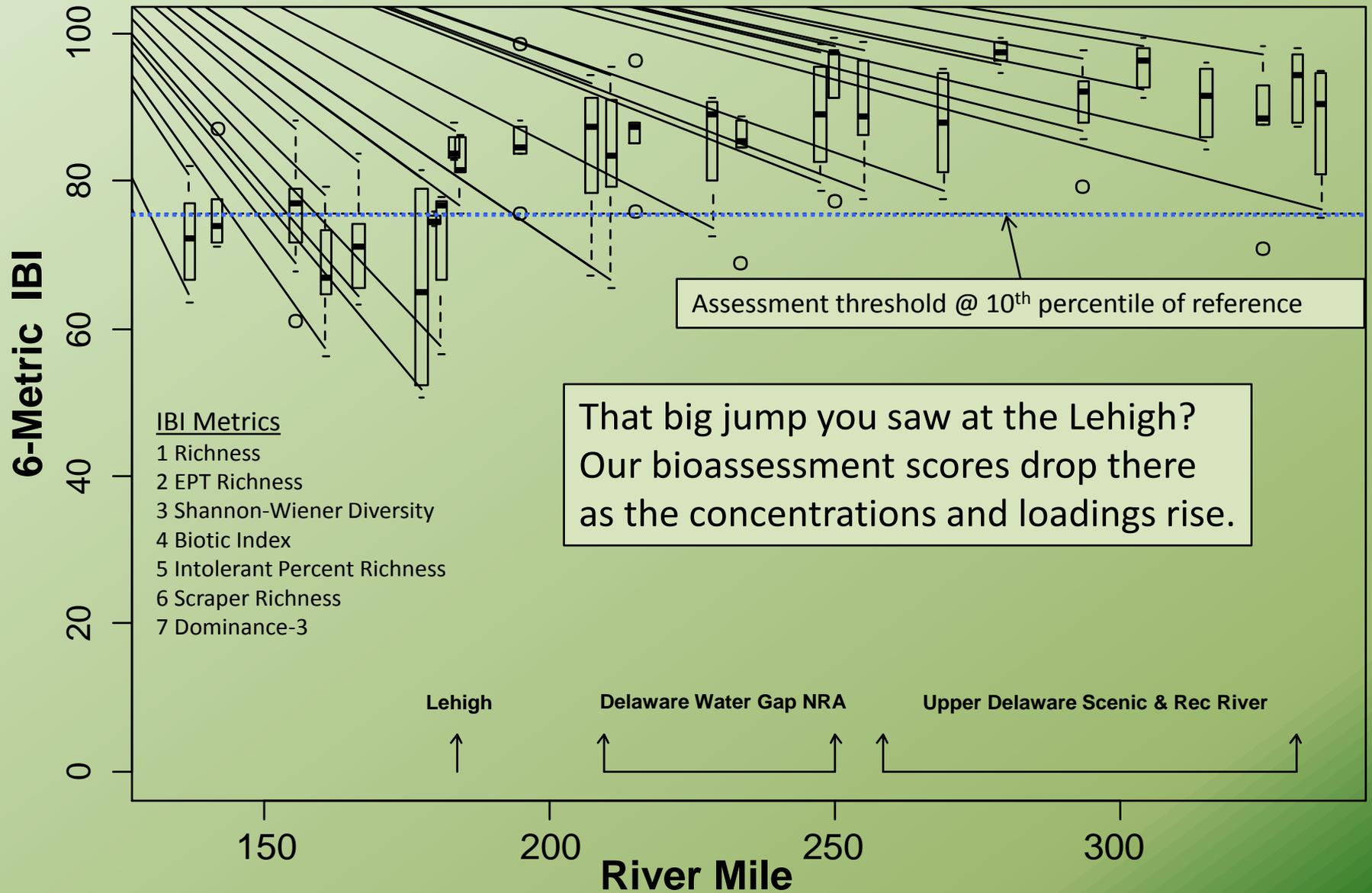
Total Nitrogen (lbs./day) May to September loadings past Delaware River ICPs vs. cumulative loadings supplied by tributaries. The modelers love these plots... For example, we can use mass balance equations to calculate where and how much to reduce Nitrogen loadings in order to improve downstream water quality. BMPs, trading, other less-regulatory tools become employed; and public participation is more focused.

Other Data Views: Loadings Normalized by Watershed Area (TDS, lbs./day/square mile) – no Pre/Post shown

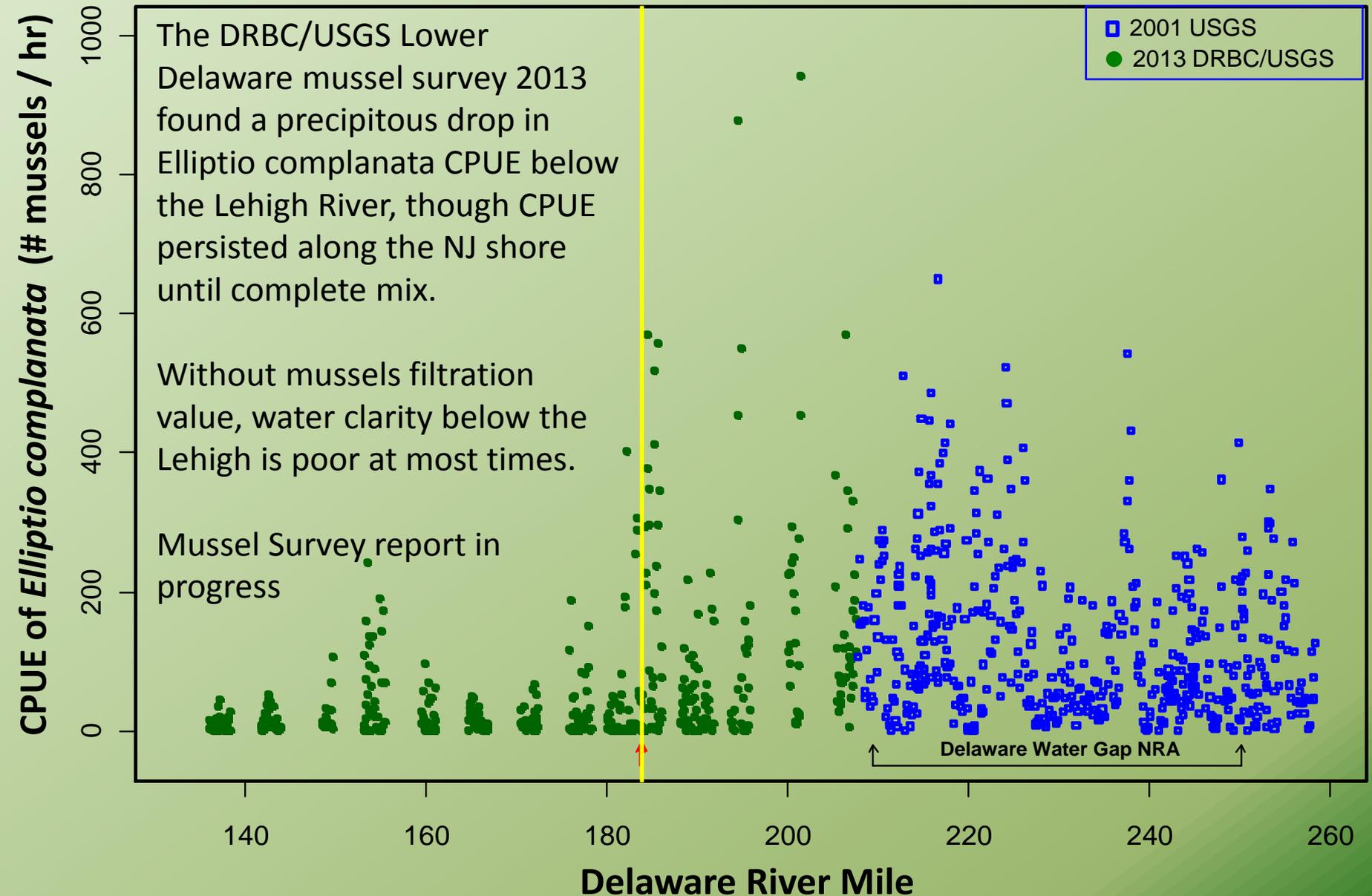


Good indicator relating to land use. I use this to rank watersheds for priority attention

Delaware R. Bioassessment: 6-metric Macroinvertebrate IBI



Elliptio complanata abundance: longitudinal plot



Data Availability

Contact Bob Limbeck (Robert.Limbeck@drbc.state.nj.us, 609-883-9522 x 230)

The reports aren't complete yet, but will be available on:

The new DRBC interactive map:

<http://www.state.nj.us/drbc/basin/map/interactive-map.html>

Special Protection Waters Data and Publications:

<http://www.state.nj.us/drbc/programs/quality/spw.html>

THANKS!



Scenic Rivers Monitoring Program Methods

- Some USGS and State data were included, as long as various conditions were met
 - Sampling must represent range of hydrologic conditions; spread across multiple months and years; same lab methods; demonstrated good QAQC at very low concentrations; etc.
- Parameters (SRMP Lab was Academy of Natural Sciences of Drexel Univ.):
 - Field measurements (DO, SpC, pH, WT, AT) – YSI meters
 - Conventionals (Alk, Hd, TSS, TDS, Cl, Turb)
 - Nutrients (Ammonia, Nitrate + Nitrite, TKN, TN, Orthophosphate, TP)
 - Bacteria (Fecal Coliform, E. coli, Enterococcus) – QC Labs, Inc.
 - Some Metals & other ions if data available (Ca, Mn, Mg, Fe, SO₄)
 - 2009-2010 Marcellus (archived) (Al, Ba, Ca, Fe, Mg, Mn, K, Na, Sr, SO₄)
- Almost NO non-detects in newer data – low level MDL's are a must for antidegradation monitoring.