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Catskill Region Water Quality Improvements with 25 Years of Watershed Protection

Lorraine L. Janus on behalf of

the Bureau of Water Supply Staff

Catskill Environmental Research and Monitoring Conference

At Belleayre, October 27- 28, 2016

Overview

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- Water quality (WQ) analytes of importance for water supply
- System attributes and WQ
- Examples of research for resource management
- WQ trends over the past 2 decades
- Explanation of trends:
  - Natural variation
  - Watershed Protection Programs

Location: The NYC Catskill and Delaware Water Supplies

What are the potential WQ issues for water supply ?

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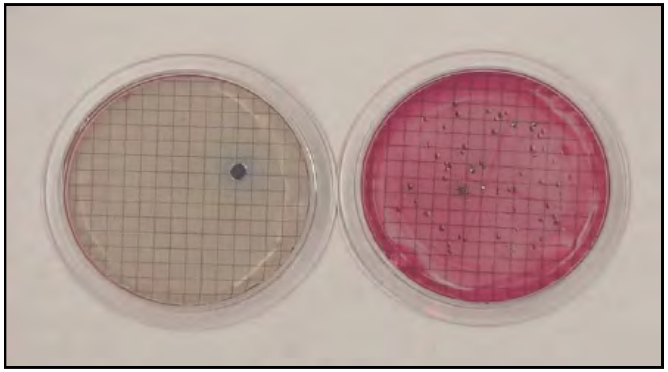
Regulations define limits for:

❖ Bacteria and pathogens

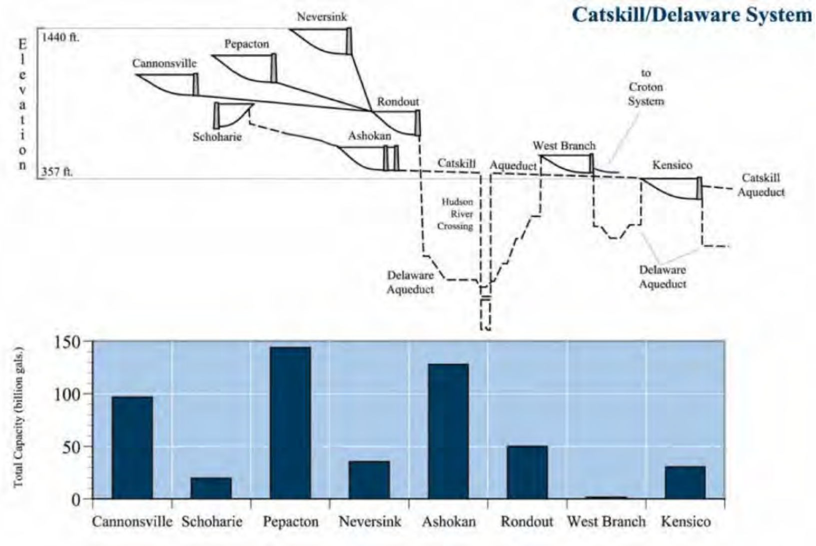
❖ Turbidity

❖ Eutrophication: taste and odor, anoxia, precursors to disinfection byproducts (DBPs)

❖ Algal blooms (potential for algal toxins, DBPs)

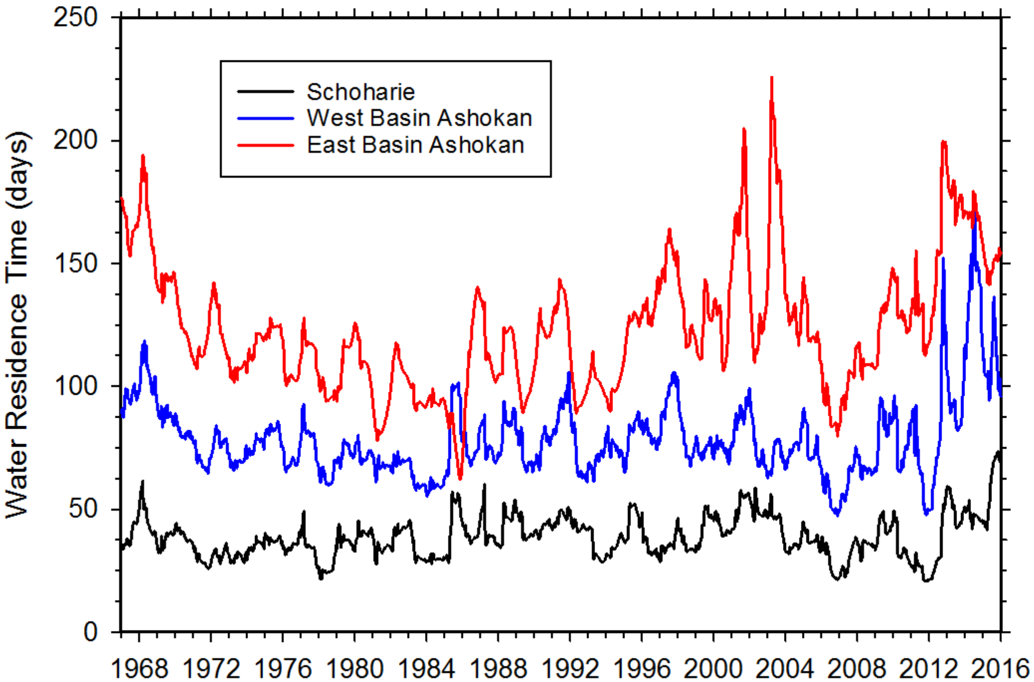


System attributes that favor excellent WQ:



- Sequential basins provide
  - Settling
  - Die off
  - Predation
- Deep basins
  - high proportion of cool water
  - low proportion of rooted aquatic plants
- Flexibility in withdrawal - best WQ goes into distribution
- Short water residence times = rapid flushing
  - range from 1.5 months (Schoharie) to 9 months (Pepacton)
- Forested land: a high proportion = low nutrient loads

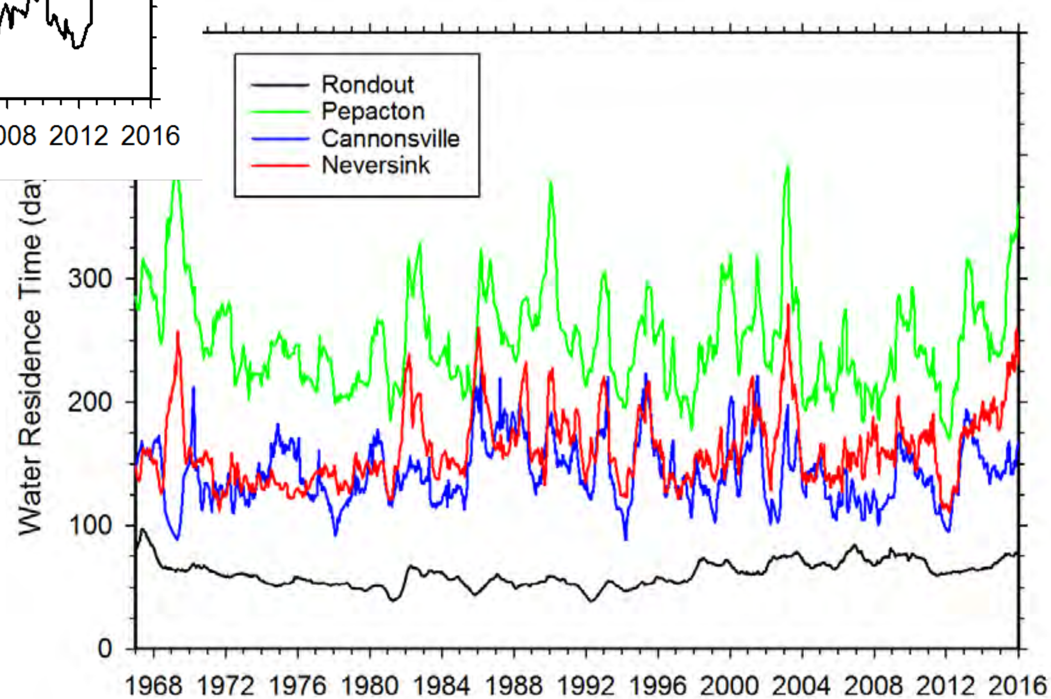
Short water residence times ~ 1 to 9 months



Catskill System Reservoirs

= High flushing rates favor excellent WQ

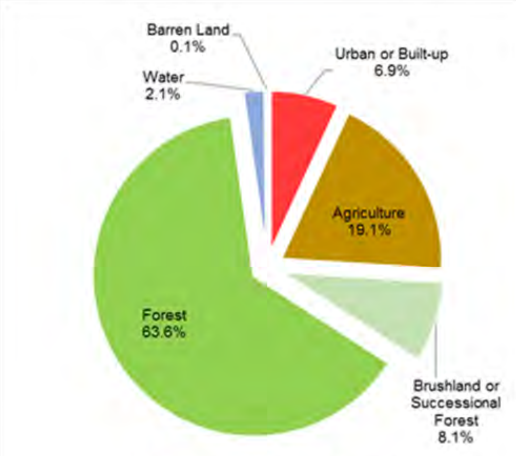
Delaware System Reservoirs



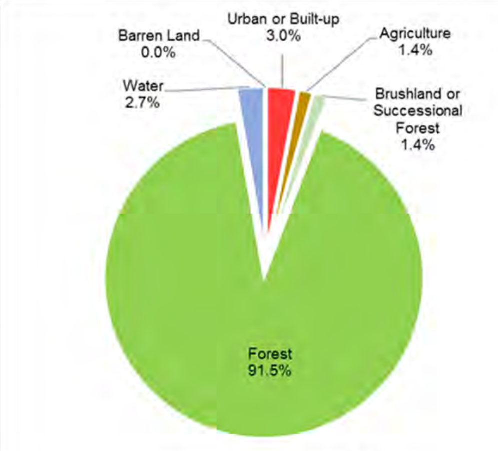
From E. Owens, WQSR

Land cover influences nutrient loads

Forest cover ranges from >60% at Cannonsville to > 90% at Neversink; Forests provide low nutrient export



Cannonsville 2009 Land Use



Neversink 2009 Land Use

How does DEP manage water quality issues?

- Constant environmental monitoring for surveillance
- Research and analysis of WQ events
  - After-Action Reports
- Modeling - guides operations and policies
- Short-term operational actions:
  - Selective withdrawal (intake depth)
  - Selective diversion (intake location)
  - Releases to streams
- Long-term policies (protection and remediation)
  - Watershed Protection Programs
  - Watershed Rules and Regulations

Despite attributes, resource management is needed!

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Regulation: Water Quality Research & Management Examples:

1. SWTR[1]: Fecal coliform control at Kensico (the source water)

2. FAD[2]: Investigaton of Cryptosporidium and Giardia sources to ensure no waterborne disease outbreaks

3. SWTR and FAD: Catskill Turbidity Control

4. DBP[3] Rule: Eutrophication control to minimize DBPs, Taste and Odor issues, and potential algal toxins

SWTR[1] = Surface Water Treatment Rule
FAD[2] = Filtration Avoidance Determination
DBP[3] = Disinfection By-Products

Example 1: Kensico Reservoir fecal coliform bacteria 1987 to 2016

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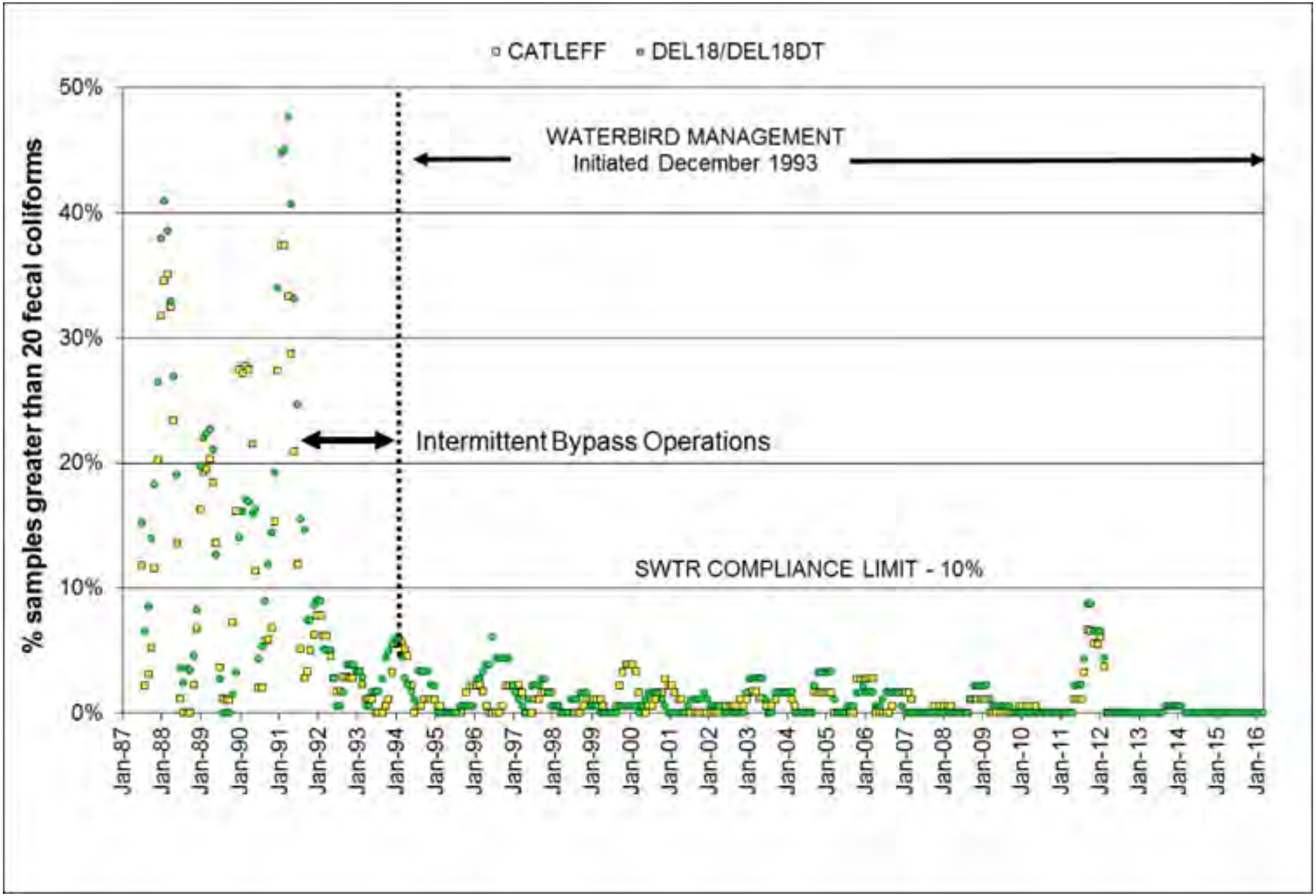
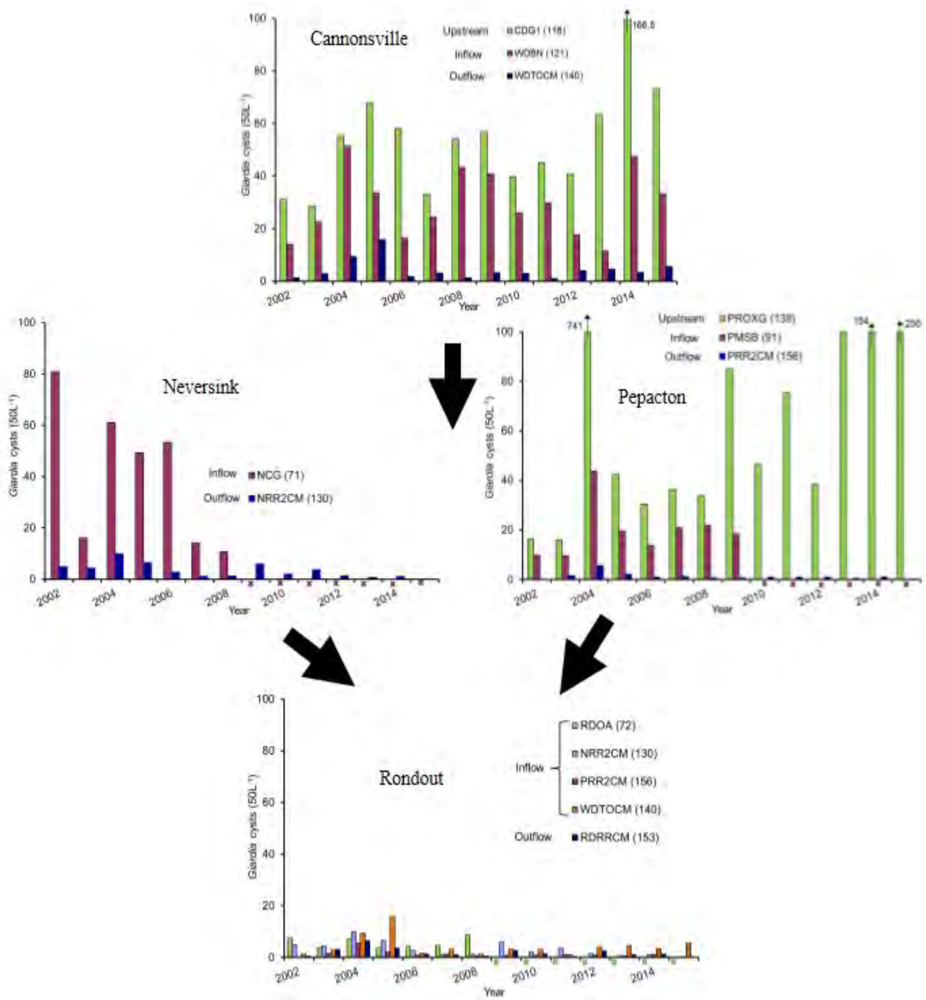


Fecal coliform research led to the Water Bird Management Program

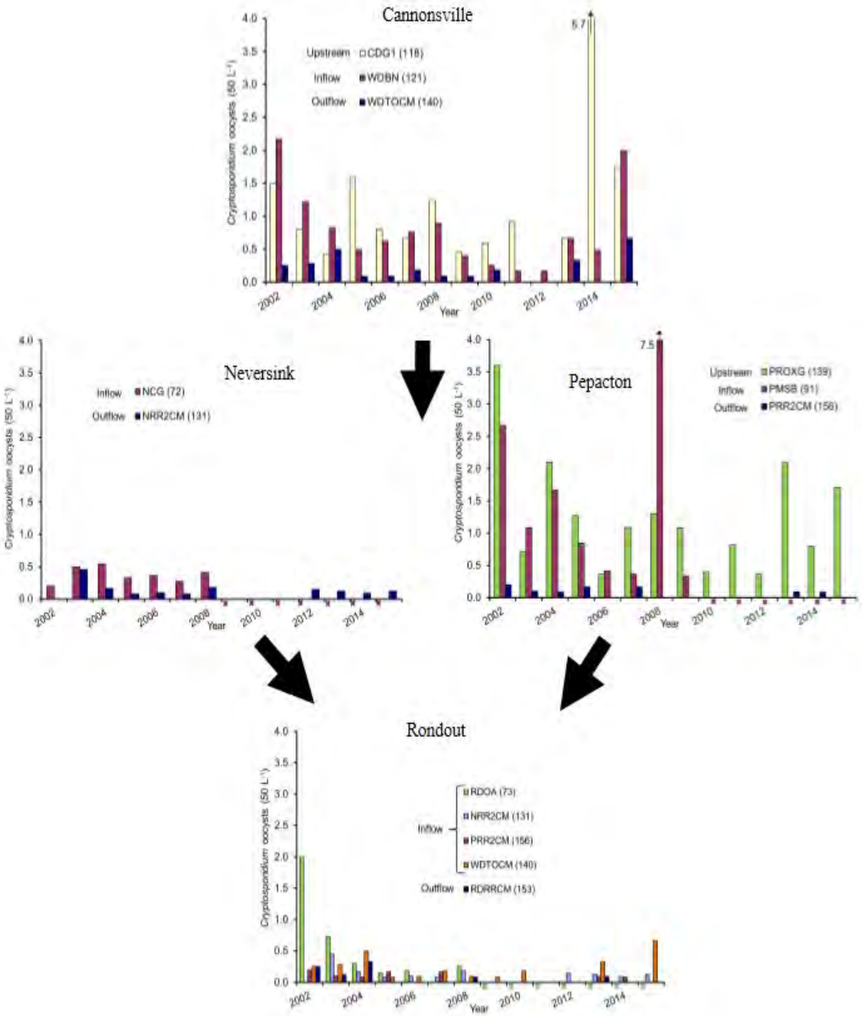
- Birds' counted and locations mapped
- 1992 fecal coliforms correlated with the presence of water birds (geese and gulls)
- Bird dispersal initiated in December 1992; great success!

Example 2: Pathogen reductions going downstream – spatial pattern

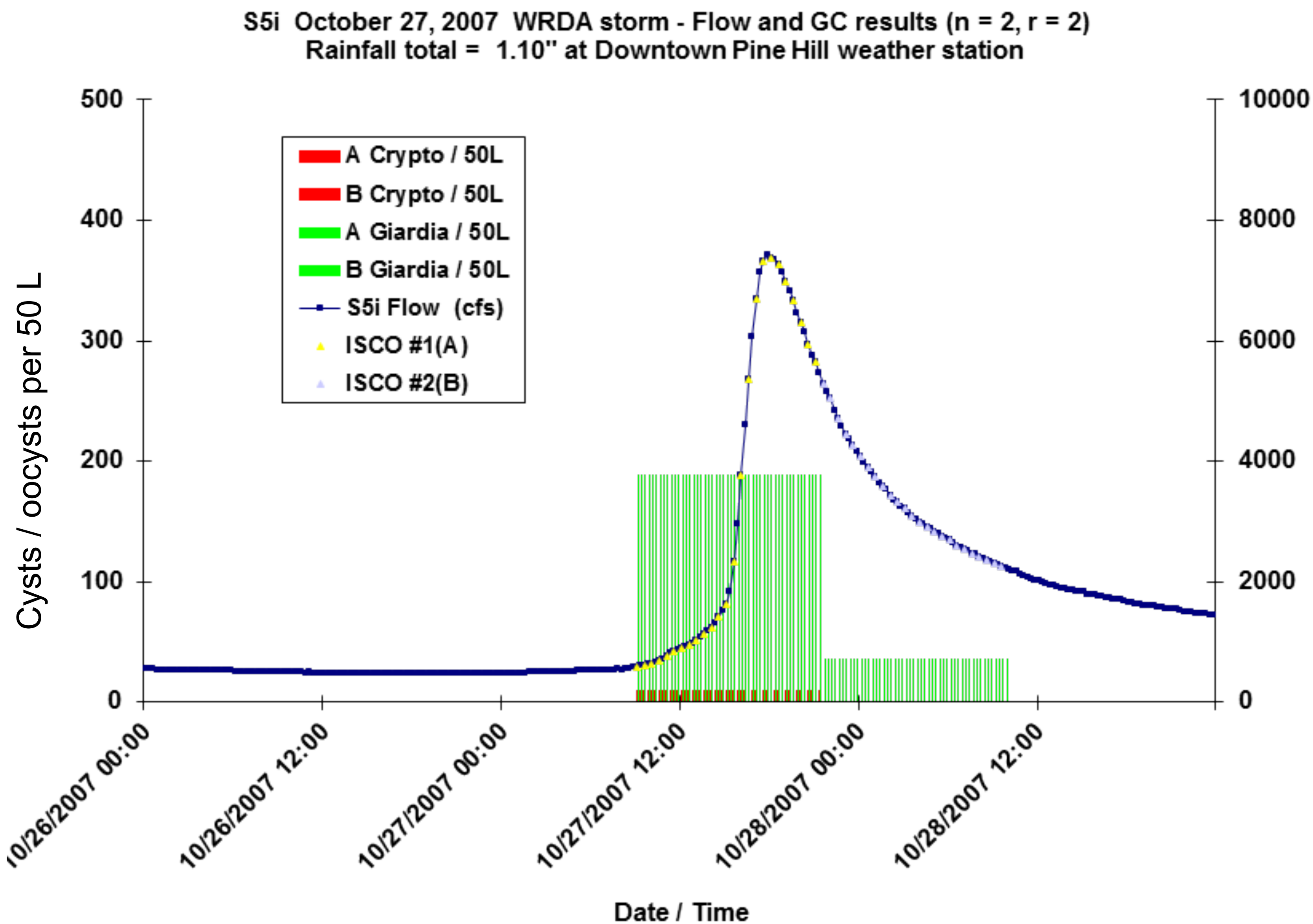
Giardia



Cryptosporidium



Pathogens peak during storms – temporal pattern



Pathogen risk reduction via watershed protection

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Whole Farm Program and stormwater control:

- Storm water runoff and streams uncoupled from dairy farm manure (a potential source of pathogens and nutrients).

- *Cryptosporidium* risk reduced by calf greenhouses to separate and prevent spread of disease.

Decline observed in pathogenic protozoans 2002 – 2015

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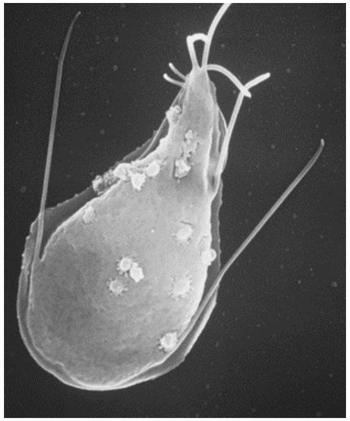
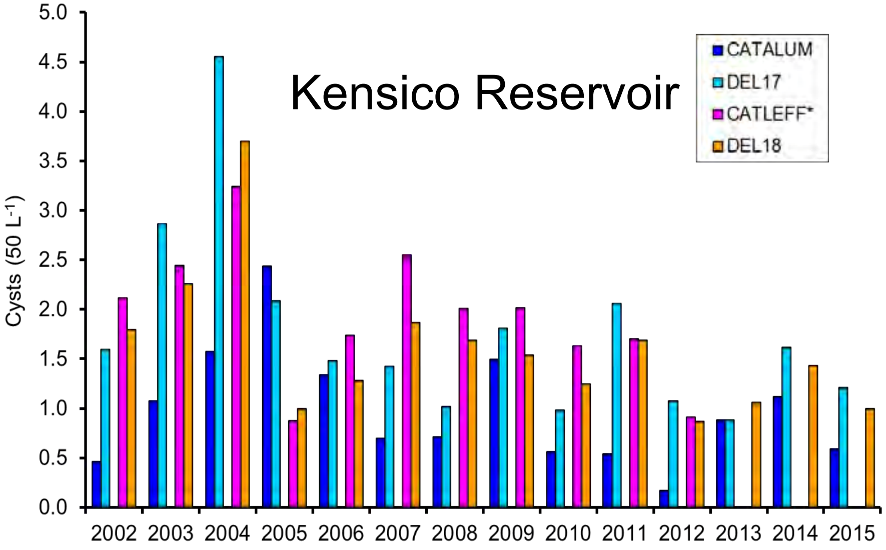
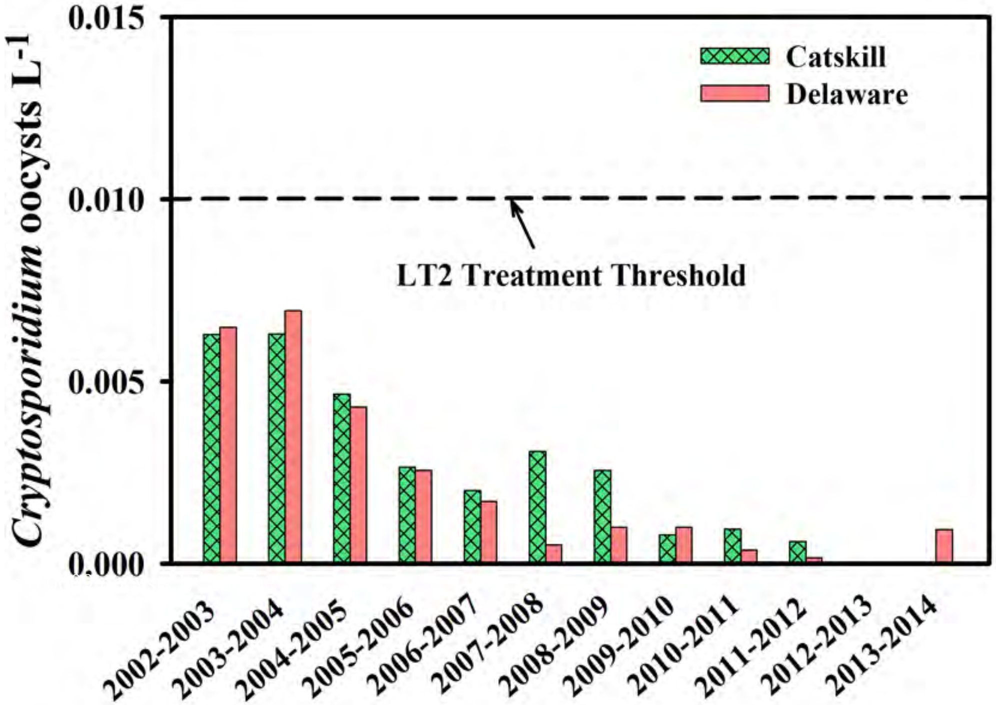
Giardia cysts

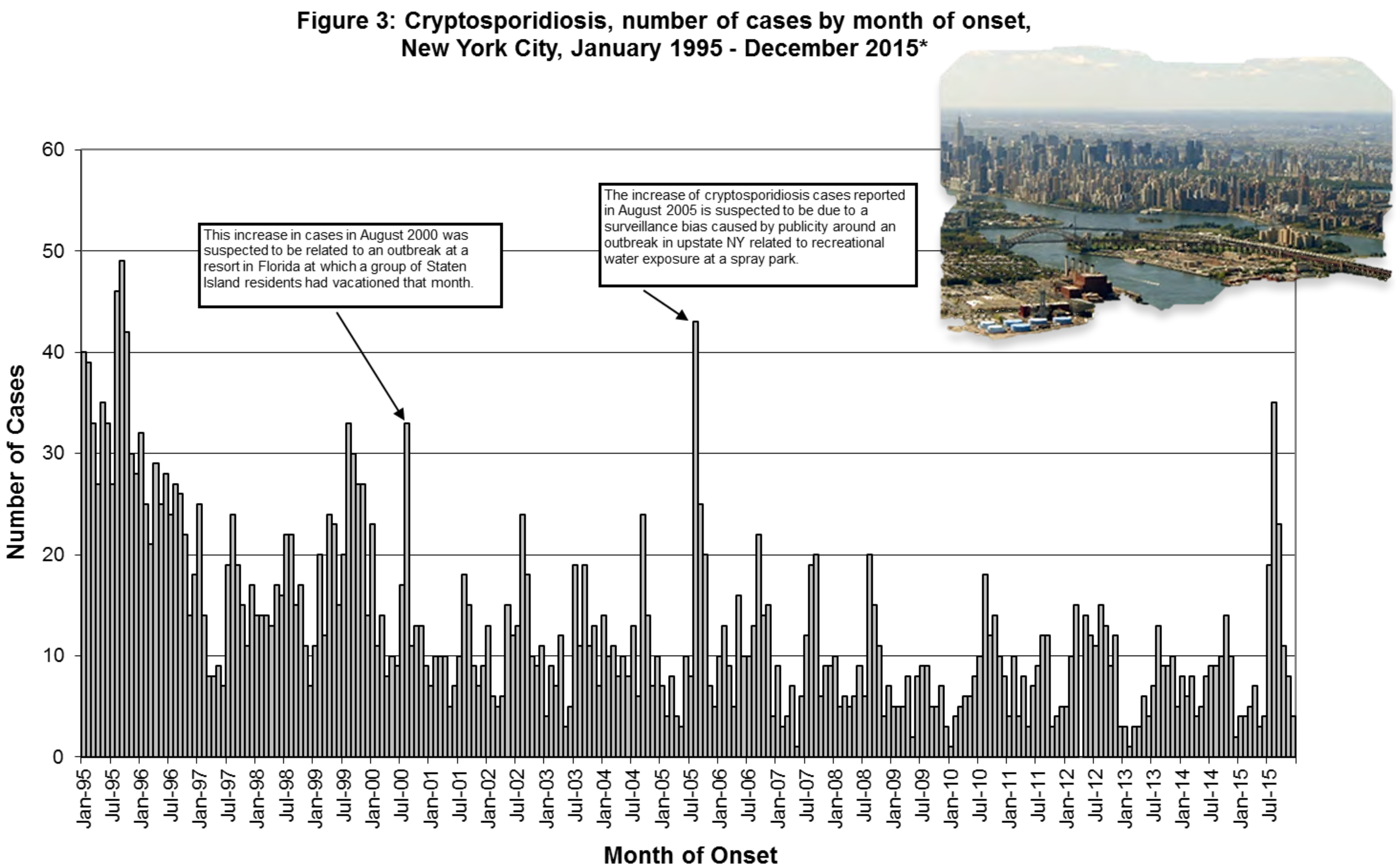




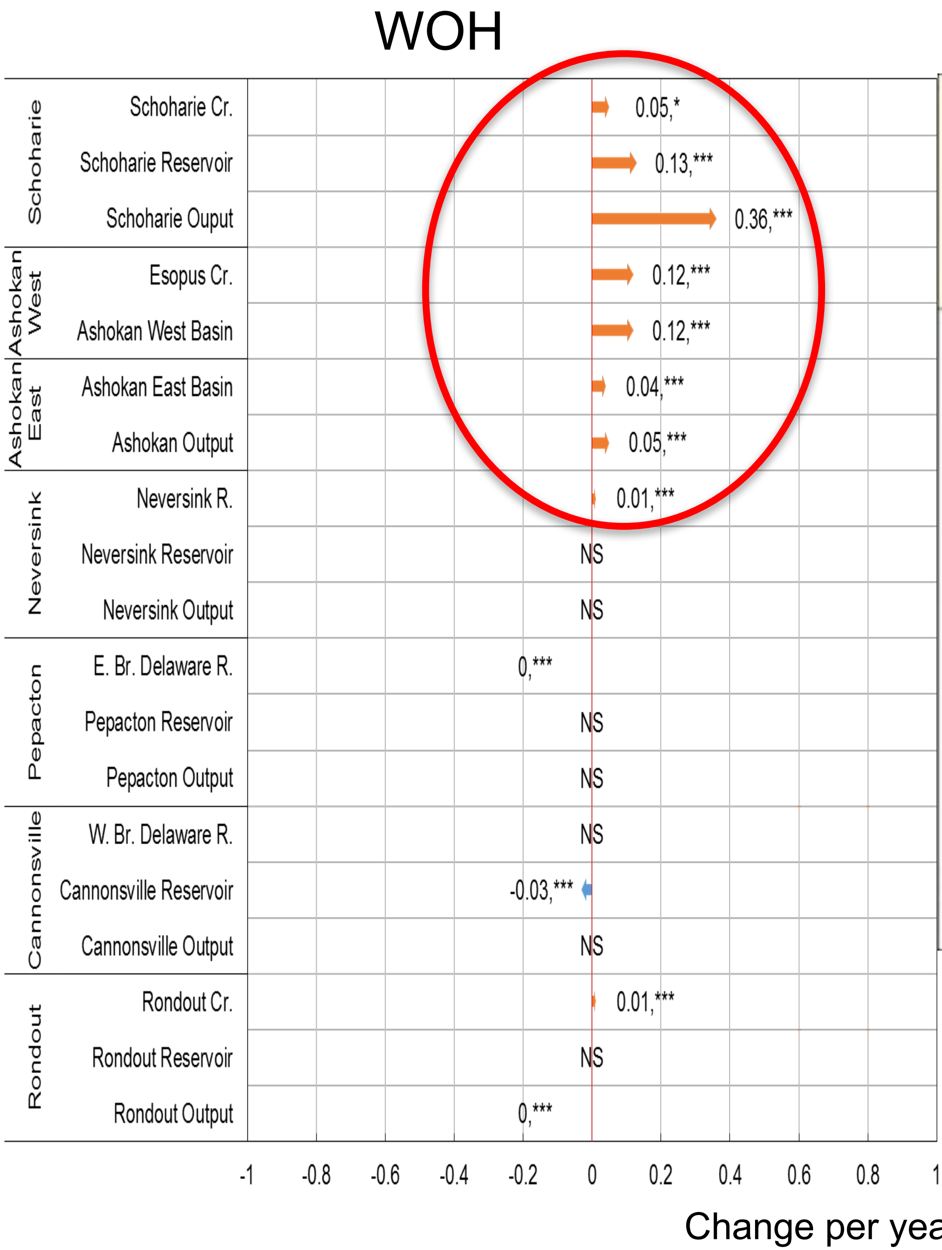
Cryptosporidium oocysts



Disease Surveillance in NYC – Cryptosporidiosis lower since 2000



Example 3: Turbidity Trends – increases seen the Catskills



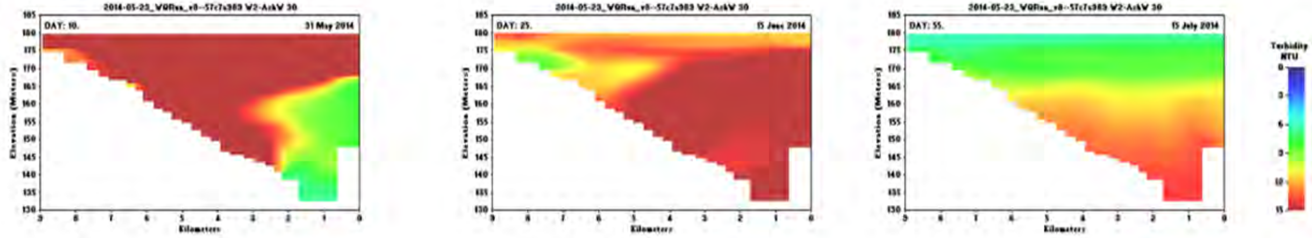
Significance: ***, Very High, p < 0.05; **, High, p < 0.10; *, Moderate, p < 0.20; NS, None, p ≥ 0.20

Extreme rainfall events drive turbidity trends

Increasing frequency of extreme events in recent years is responsible for upward trend in turbidity in the Catskills.

Short-term management of turbidity

- ❖ Model runs guide operations



- ❖ Operational changes may exclude high turbidity
- ❖ Alum treatment of the Catskill aqueduct in extreme cases

Long-term policy for Stream Management

❖The Stream Management Program goal is to protect and restore stream system stability and ecological integrity through stream management plans.

❖Stream projects employ in-stream, riparian, and floodplain practices to reduce in-channel sources of suspended sediment.

Figure 4.18. Warner Creek Site 5, pre-construction.

Figure 4.19. Treatment for Warner Creek Site 5 included channel realignment, in-stream rock structures, a rock terrace, and re-constructed hill slope.

From D. Davis

Example 4: Eutrophication and algae control

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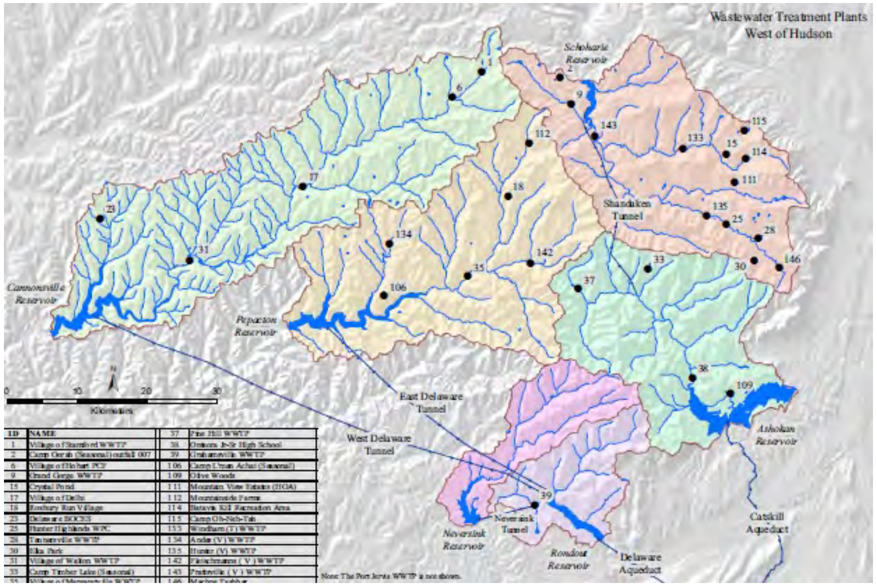
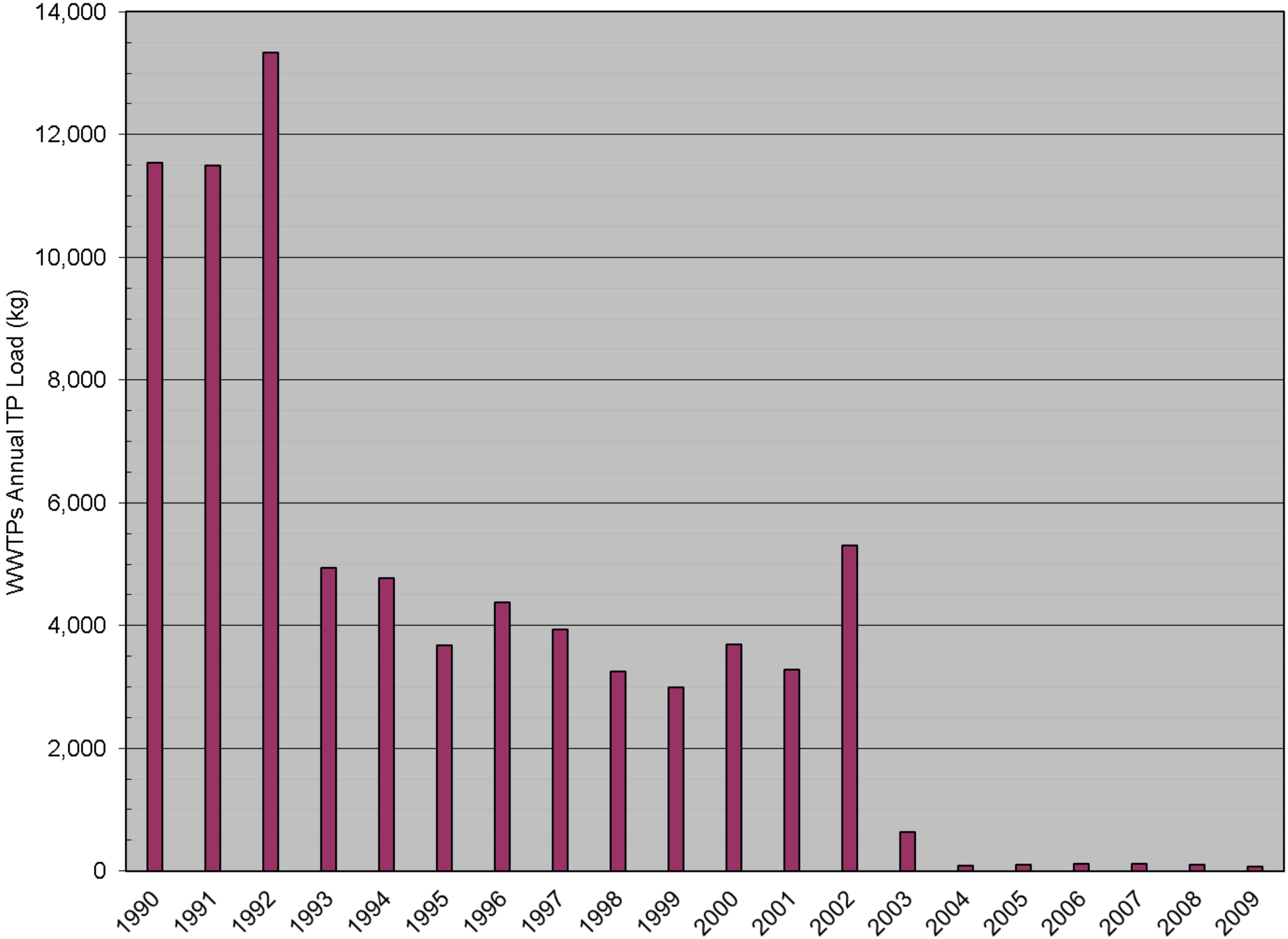
Phosphorus reductions by several programs

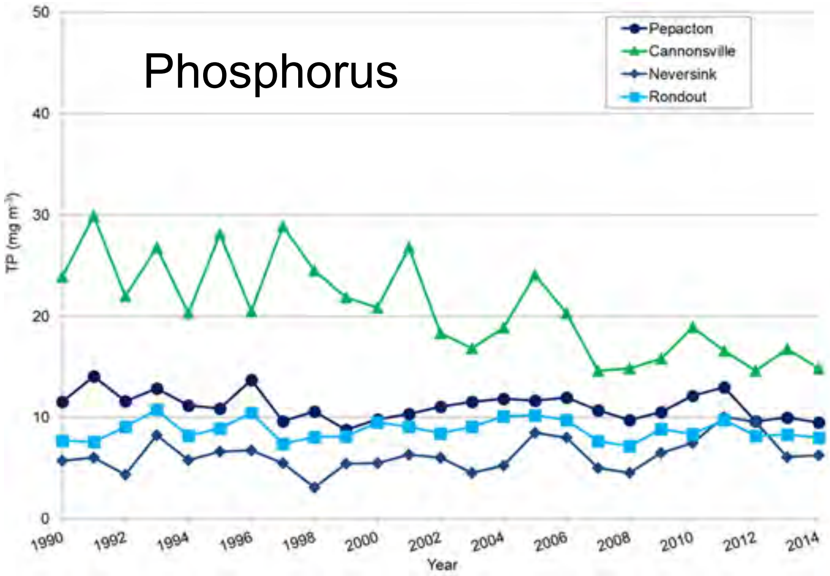
Watershed Protection and Partnership Programs	1997 (sites or projects)	2015 (sites or projects)
Whole farm plan participants	51,307 acres	84,541 acres (92% participation)
WWTP nutrient load	6,250 kg TP/year	290 kg TP/year (2014)
Remediated septic failures	252	4,839

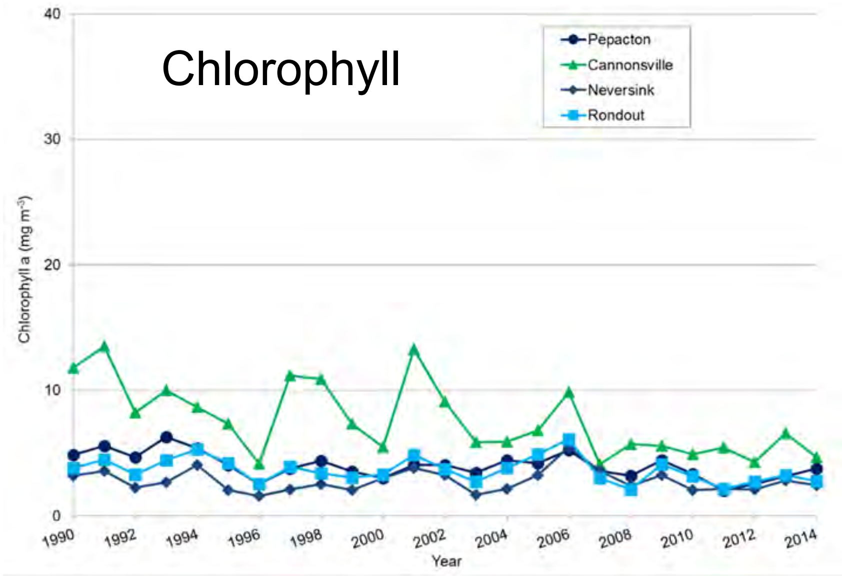
30 WWTPs in the Catskill/ Delaware region were upgraded reducing reservoir loads by ~ 6 metric tons of TP since 2000.



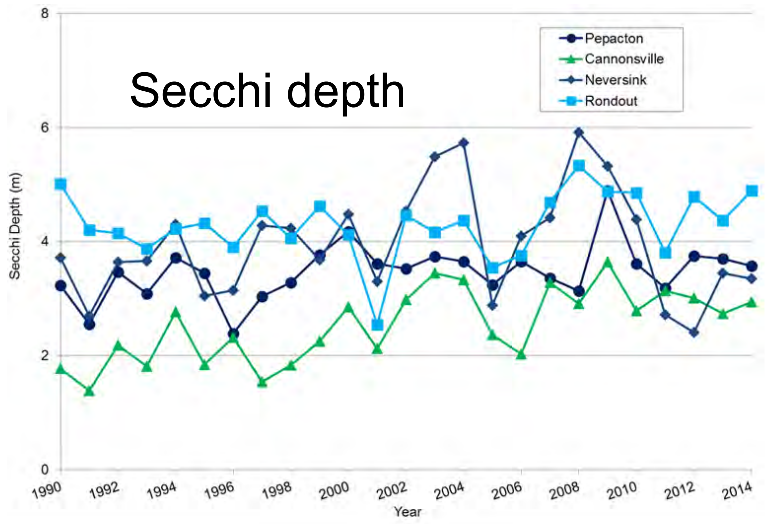

WWTPs Annual TP Load (kg)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

Delaware Reservoir responses to nutrient reductions: 1990 – 2014





- Cannonsville TP and Chl decreased after 2000 with WWTPs and Ag programs
- Transparency increasing except when major storms occur



Phosphorus reductions have resulted in algal reductions

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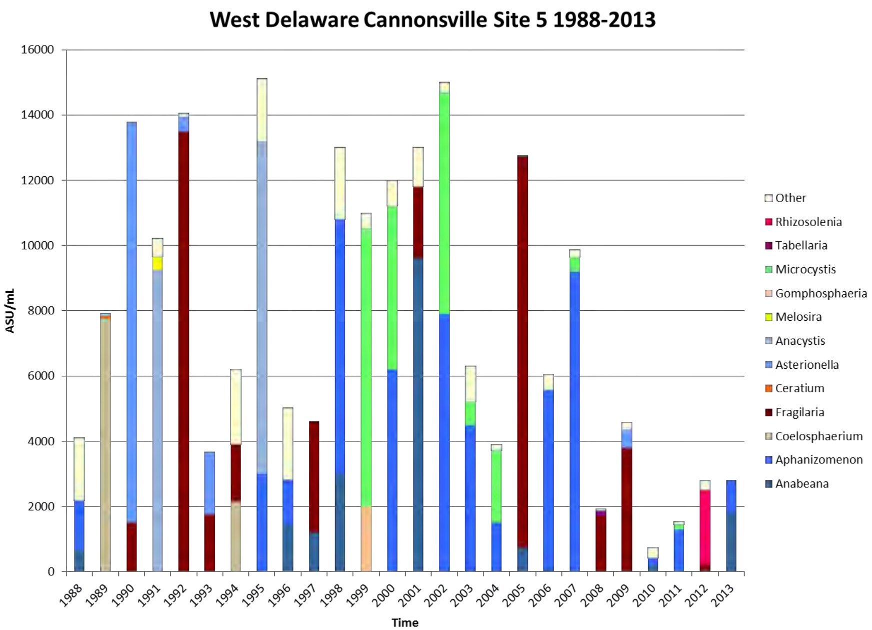
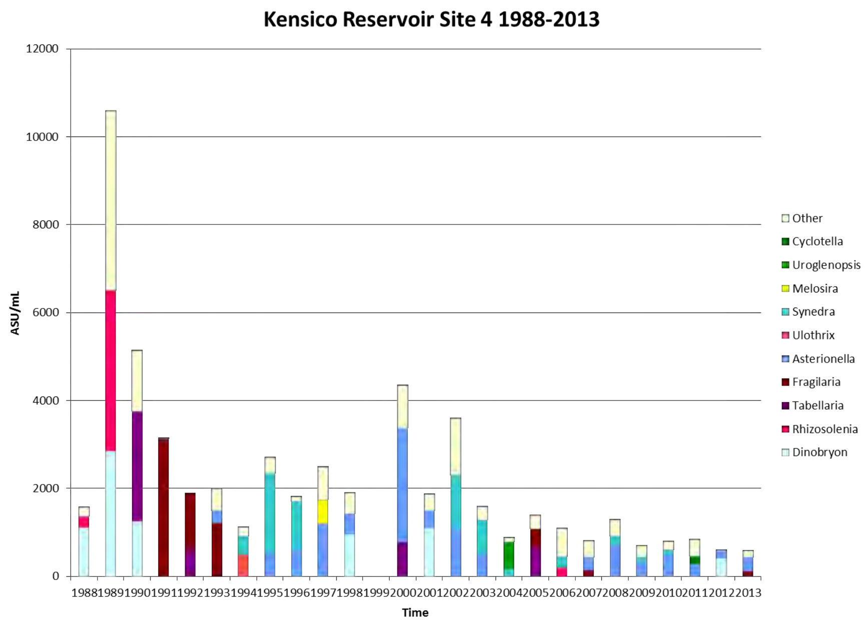
- Algae have decreased since 2000 with WWTP upgrades
- Algal species have changed from blue greens to diatoms
- No chemical treatments for algae since 1996

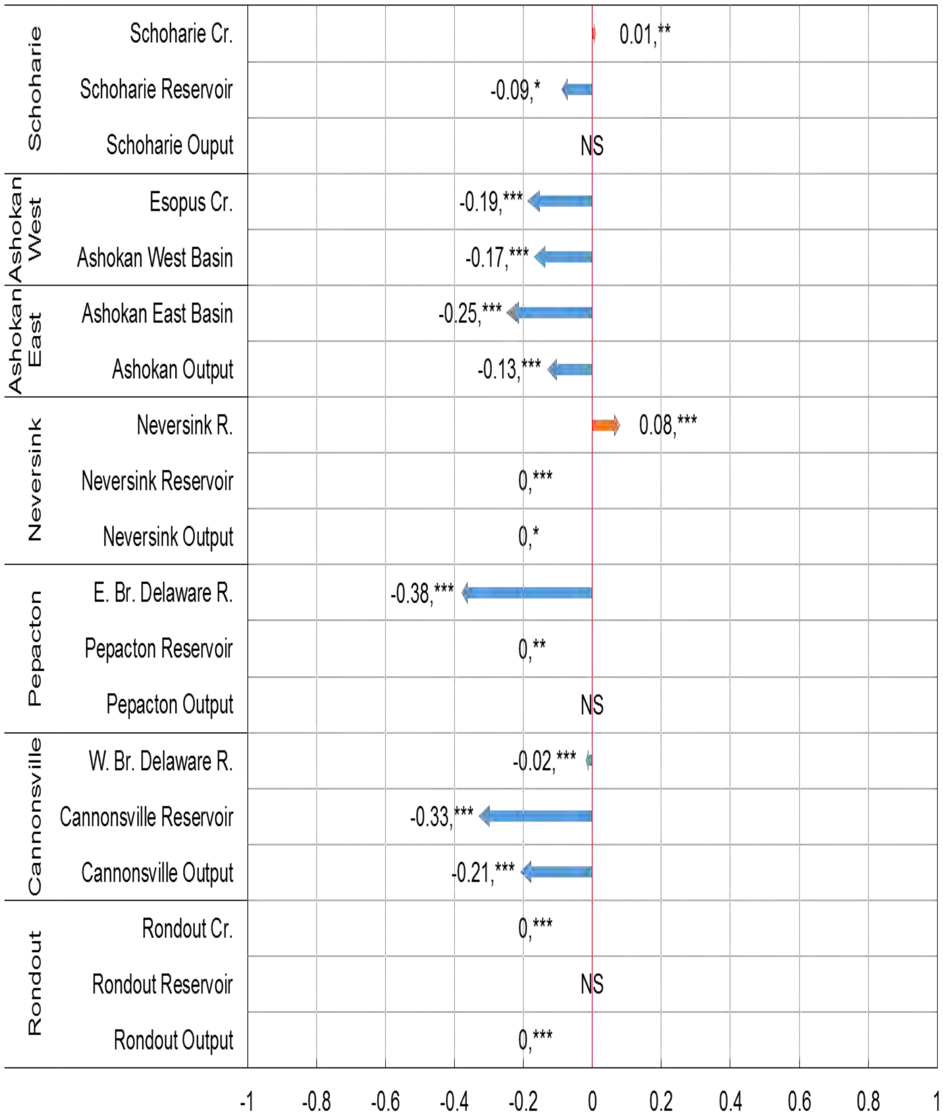
Upstream Cannonsville Reservoir

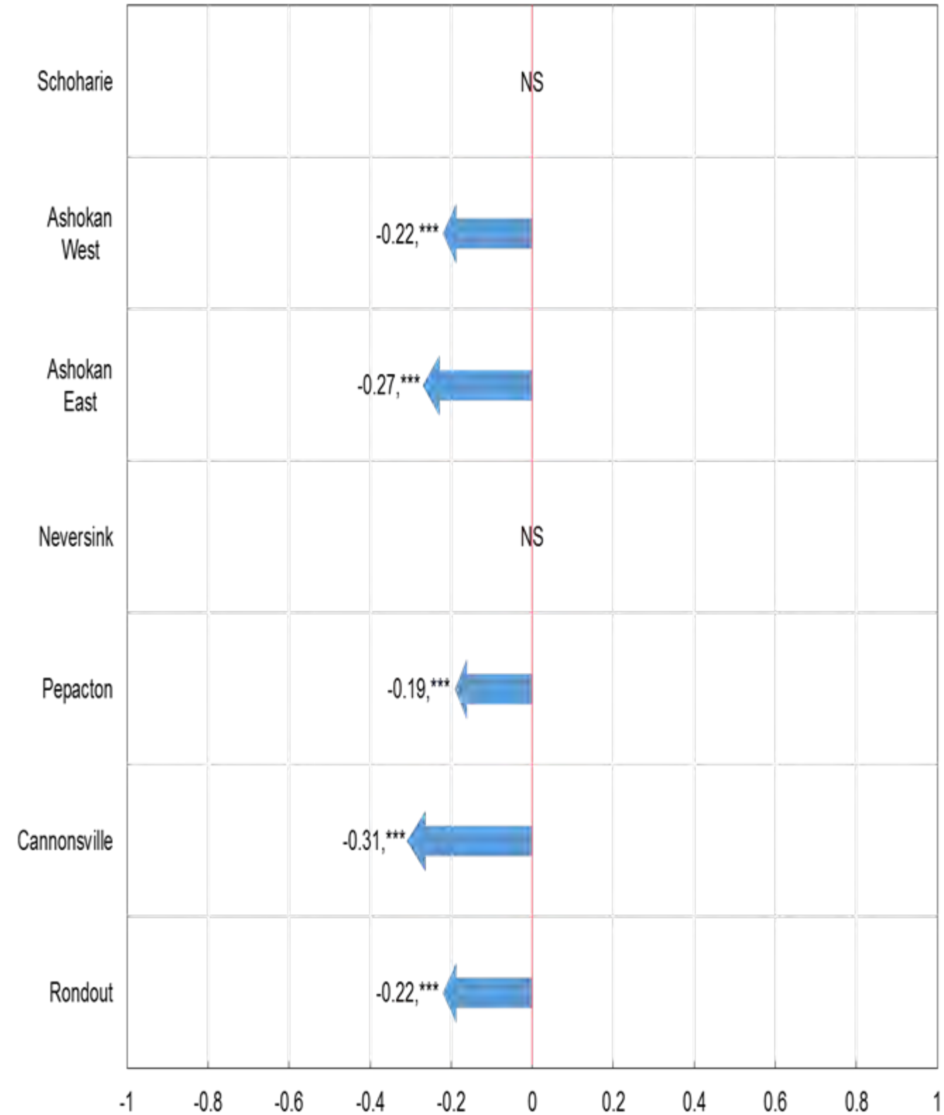


Downstream Kensico Reservoir



Both total phosphorus and trophic state trends downward



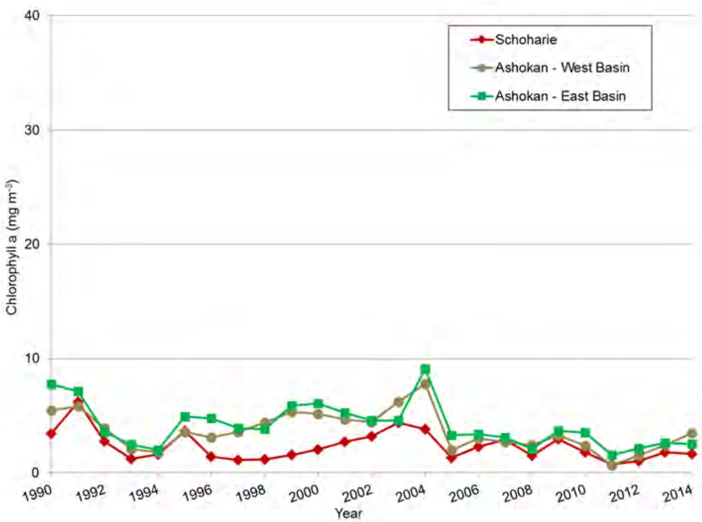


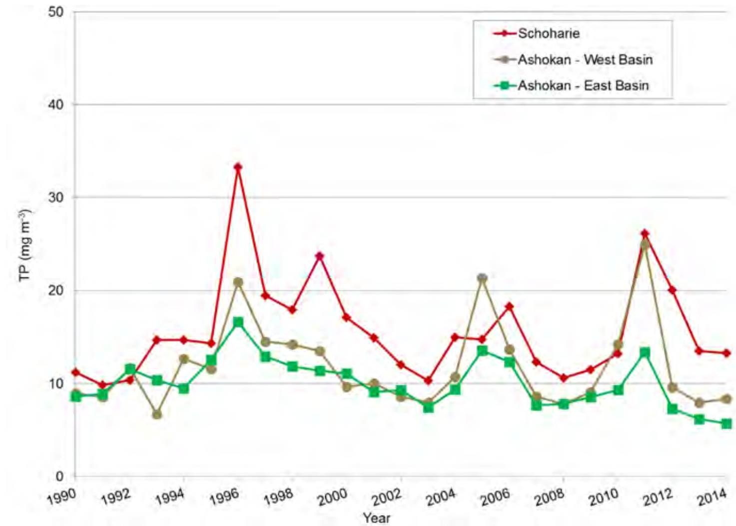
Change per year (µg/L/year)

Significance: ***, Very High, p < 0.05; **, High, p < 0.10; *, Moderate, p < 0.20; NS, None, p ≥ 0.20

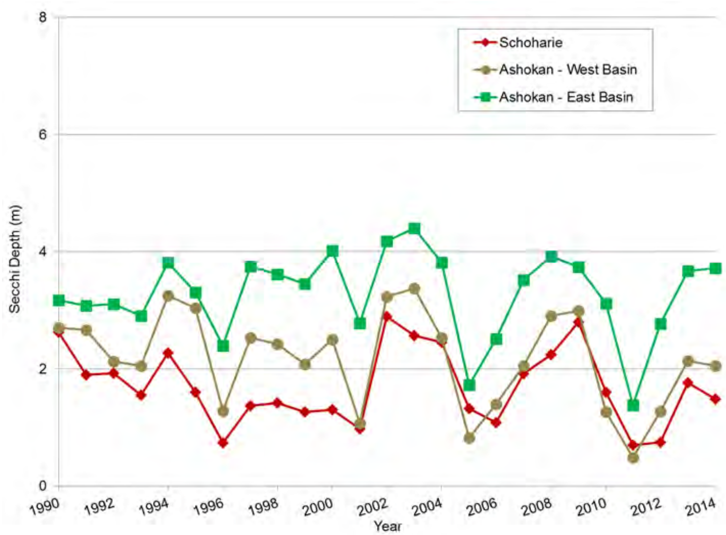
Long-term Trophic response to turbidity

Catskill Reservoirs: 25 years

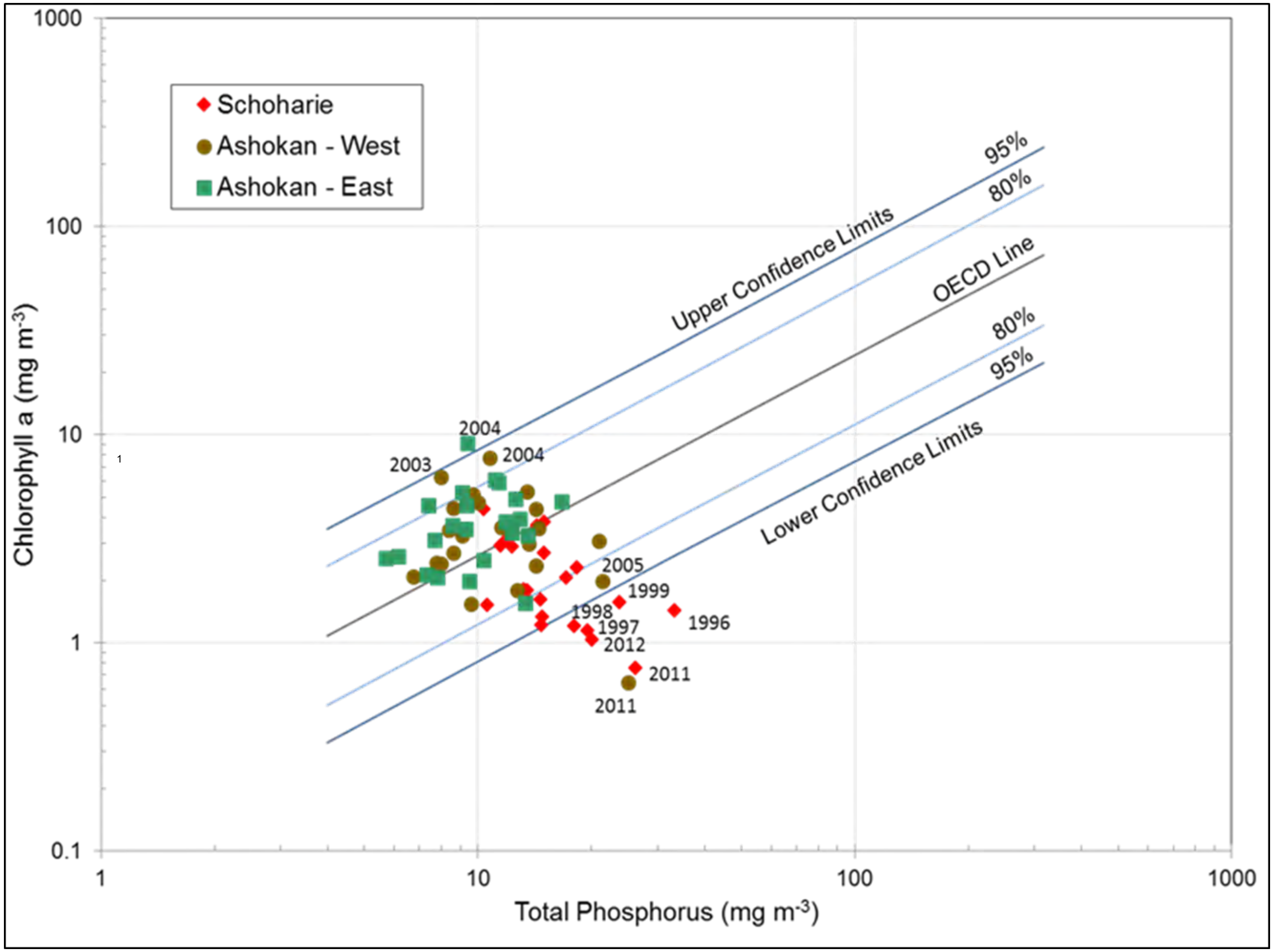




- ❖ No chlorophyll trend; light limited
- ❖ TP peaks with major storms
- ❖ Transparency drops sharply with storms and turbidity events



Turbidity controls trophic response of Catskill reservoirs



Chl (algae) vs phosphorus (nutrient):

- Higher TP is associated with particles that reduce transparency and shade algae

Conclusions: Filtration Avoidance Supported

- ❖ Research and science are essential for water supply management and policy development (4 examples were presented).
- ❖ Fecal coliform bacteria are controlled through Waterfowl Management and stormwater control – source identification was key.
- ❖ Pathogens (*Giardia* and *Cryptosporidium*) are maintained at very low levels through the Whole Farm Program, WWTP membrane filtration, and stormwater control.
- ❖ Turbidity trends upward are the result of recent severe storms; control is maintained through modeling, operations, and the Stream Management Program.
- ❖ Phosphorus trends downward are due to WWTP upgrades since 2000, the Whole Farm Program, and septic repairs.
- ❖ Trophic state and chlorophyll declines reflect phosphorus reductions.
- ❖ The Catskill System reservoirs do not have high algal production due to shading by turbidity, despite TP increases due to floods.
- ❖ All long-term improvements in water quality indicate a strengthened case for NYC's Filtration Avoidance!

Acknowledgements

Environmental Protection

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- Modeling
- Health Assessment and Policy Coordination
  - Anne Seeley

Thank You

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