Comparison of Two Field Filters for the Collection of Viruses from Surface Water in the New York City Watershed

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Outline

- Background on HEV program
- Filter descriptions
- Side-by-side filter comparison
  - Field observations
  - Lab results
- Routine data since filter change
- NanoCeram 10” trials
- Current status of sampling
- Conclusions

Virus Sampling - Background

- DEP virus monitoring program began…

  1995 at Kensico effluents and CATALUM

- ICR Method 200-300L volume collected

  - uses CUNO Virosorb© 1MDS filter

- Approximately 311 samples / year (2010)

	Annual
❖ Weekly @ 5 keypoints	260
❖ Bi-monthly @ BSTP	6
❖ Quarterly @10 WWTPs	40
❖ Annually @ 5 streams/releases	5
Total # samples	311

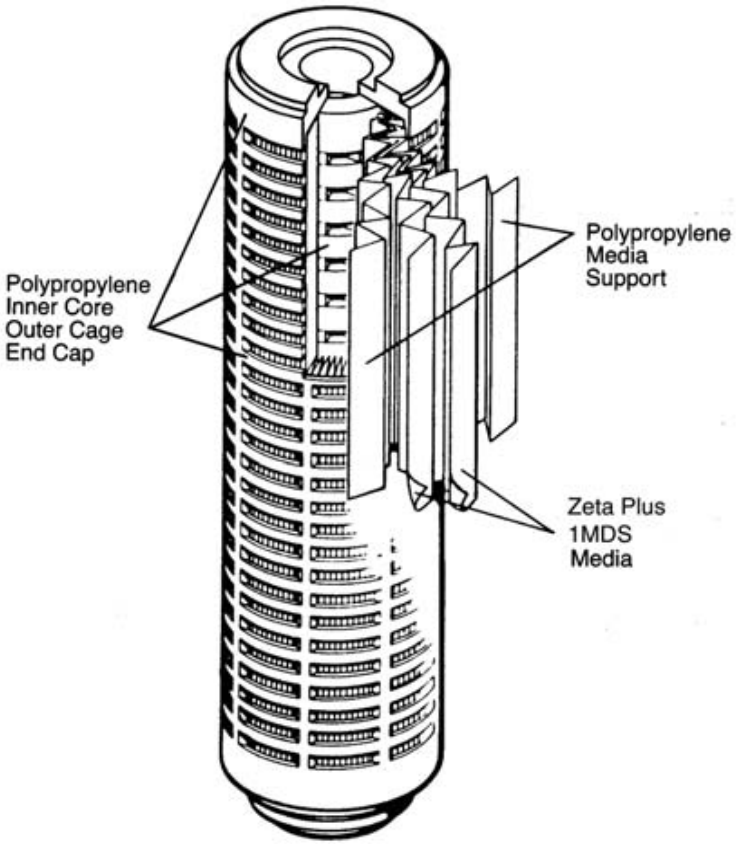
NYC Cost per filter = $137.13

Annual filter cost > $42,600

DEP Virus Sampling

CUNO Virosorb 1 MDS Filter

- Electropositive filter media
  - Charge modified glass and cellulose medium
  - Filters viruses by adsorption as opposed to mechanical filtration
  - 10 µm nominal pore rating
  - 10 inch filter with double layer of 1MDS media
- CUNO filter allows for:
  - High flowrate (DEP @ 10 lpm)
  - Pressure up to 30 psi
  - Sampling at pH < 9.0



CUNO Virosorb© Filter Cartidge

NanoCeram® Filter Alternative

(Argonide Inc. Sanford, FL)

Non-woven matrix of microglass fibers coated with boehmite-derived nanoalumina fibers

- extensive surface area

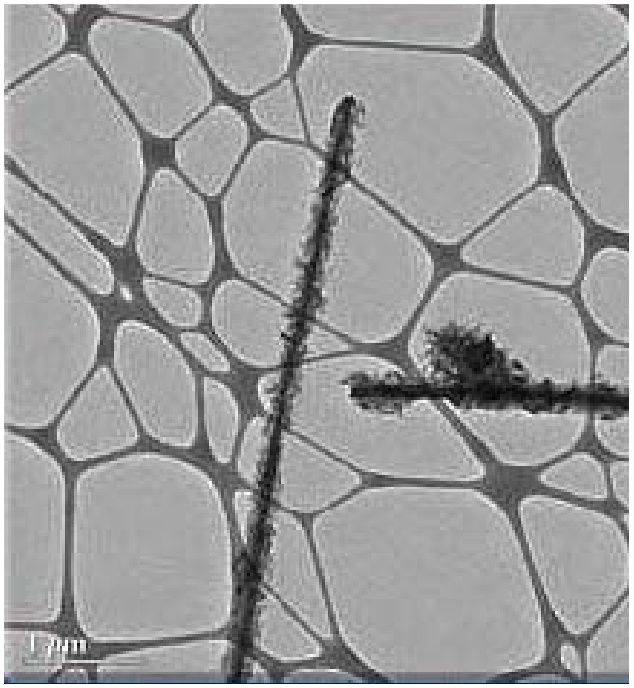
  (~500 m^2/g)

- high electropositive charge
- 2-3 micron pore (physical)
- 0.2 micron effective pore

  (Absolute rating)

- 5” filter (10” now available)
- NYC cost per filter = $46.00

  (~67% less)



Side by Side Filter Comparison

- **Environmental samples (13 pair) (Jan ’11–May ’11)**
  - Range of 200 – 300 L filtered
  - 3 @ CATALUM (aqueduct)
  - 5 @ DEL17 (aqueduct)
  - 5 @ HH7 (stream)
- **Matrix Spike samples (2 pair)**
  - 290L filtered in field + 10L grab in cubitainer
  - 10L cube spiked with approx 200PFU
  - Filtered through 290L filter = 300L
- **QC samples filtered by lab (5 pair)**
  - Run weekly for each filter type
- **Processed by ICR Method**

CUNO Virosorb© 1MDS

Argonide NanoCeram®

CUNO vs NanoCeram - Turbidity and Pressure

DATE	SITE	VOLUME FILTERED (liters)	TURBIDITY (ntu)	CUNO PRESSURE (psi)	NANO 5" PRESSURE (psi)
1/10/2011	CATALUM	240	10.6	6	54
1/13/2011	CATALUM	300	18.2	12	100
1/18/2011	CATALUM	290	14.1	10	50
1/24/2011	CATALUM	290	10.5	26	100
1/31/2011	CATALUM	300	6.2	8	20
4/11/2011	DEL17	300	1.6	4	18
4/13/2011	HH7	300	8.4	0	60
4/18/2011	DEL17	300	1.4	4	32
4/20/2011	HH7	300	6.6	8	15
4/25/2011	DEL17	300	1.1	4	32
4/27/2011	HH7	300	1.4	12	18
5/2/2011	DEL17	300	1.3	6	6
5/4/2011	HH7	300	1.8	10	20
5/9/2011	DEL17	300	0.9	0	28
5/11/2011	HH7	300	1.3	0	15

Side by Side Comparison 2011 - Pressure Issues

- ICR method states pressure should not exceed 30psi
- DEP experienced significant pressure increase using NanoCeram 5” filters, especially with high turbidity
- Ideal flow range = 5 - 10 LPM according to SOP
- High pressure = lower flow rate = longer filter time

Detections

Date	Site	CUNO Virosorb	NanoCeram 5”
1/10/2011	CATALUM	n	n
1/13/2011	CATALUM	n	n
1/31/2011	CATALUM	n	n
4/11/2011	DEL17	n	n
4/13/2011	HH7	y	y
4/18/2011	DEL17	n	y
4/20/2011	HH7	y	n
4/25/2011	DEL17	n	n
4/27/2011	HH7	y	y
5/2/2011	DEL17	n	n
5/4/2011	HH7	y	n
5/9/2011	DEL17	n	n
5/11/2011	HH7	y	y
		5	4

Concentrations

Date	Site	CUNO Virosorb	NanoCeram 5”
1/10/2011	CATALUM	0	0
1/13/2011	CATALUM	0	0
1/31/2011	CATALUM	0	0
4/11/2011	DEL17	0	0
4/13/2011	HH7	8.63	7.03
4/18/2011	DEL17	0	1.03
4/20/2011	HH7	1.03	0
4/25/2011	DEL17	0	0
4/27/2011	HH7	2.11	1.03
5/2/2011	DEL17	0	0
5/4/2011	HH7	2.11	0
5/9/2011	DEL17	0	0
5/11/2011	HH7	24.08	10.22
	Mean	2.92	1.49

Positive Flasks

Number of Flasks Positive

Date	Site	CUNO Virosorb	Argonide NanoCeram 5”
4/13/2011	HH7	7	6
4/18/2011	DEL17	0	1
4/20/2011	HH7	1	0
4/27/2011	HH7	2	1
5/4/2011	HH7	2	0
5/11/2011	HH7	14	8
	Total	26	16

Quality Control - Matrix Spike Samples

Date	Site	CUNO Recovery	Nano 5” Recovery
1/18/2011	CATALUM	16.93%	25.05%
1/24/2011	CATALUM	35.33%	40.45%

Quality Control – DI spikes

(Percent Recovery)

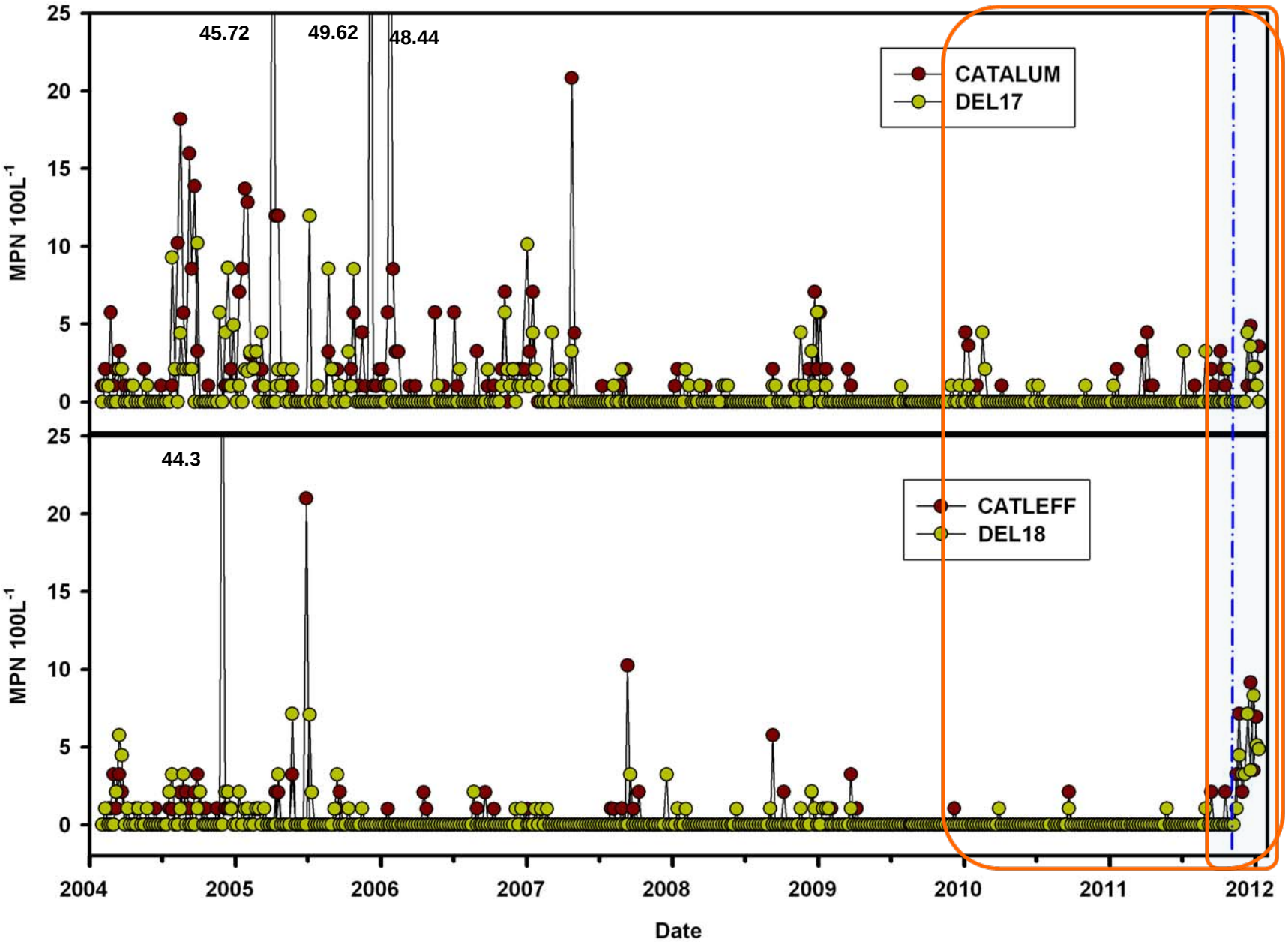
QC for samples…	CUNO Virosorb	Argonide NanoCeram 5”	
4/11/2011	140.3	151.7	
4/18/2011	126.1	87.9	
4/25/2011	93.3	171.0	
5/2/2011	150.2	135.8	
5/9/2011	104.1	138.5	
	122.8	136.98	Mean
	23.92	30.77	St Dev
	126.1	138.5	Median

Recent change to NYC's virus method…

Switch to NanoCeram© 5" filters – Nov. 7, 2011

***Continue to use CUNO filters at CATALUM (turbidity issue)**

Kensico Keypoint HEV data (thru Dec '11)



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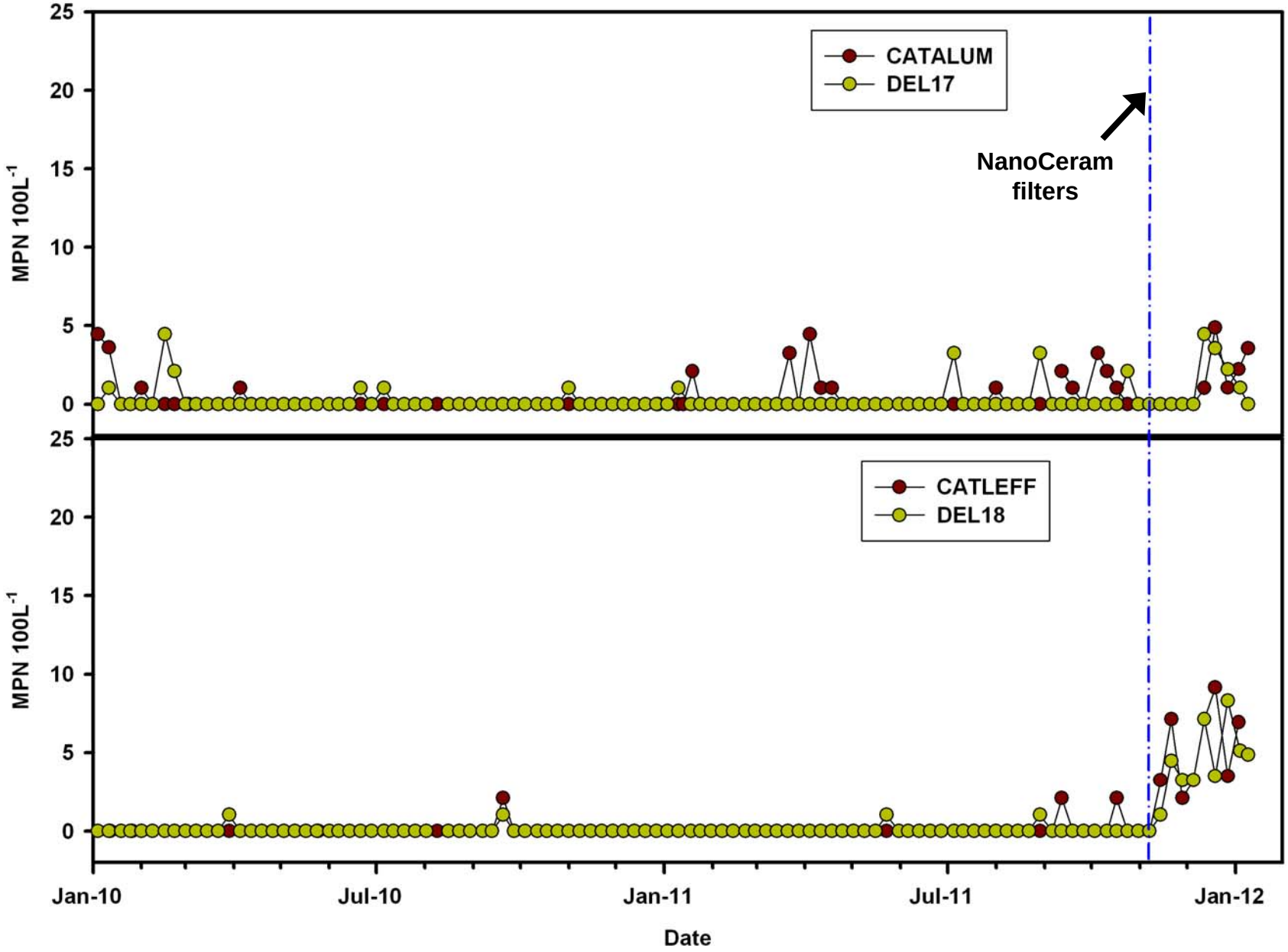
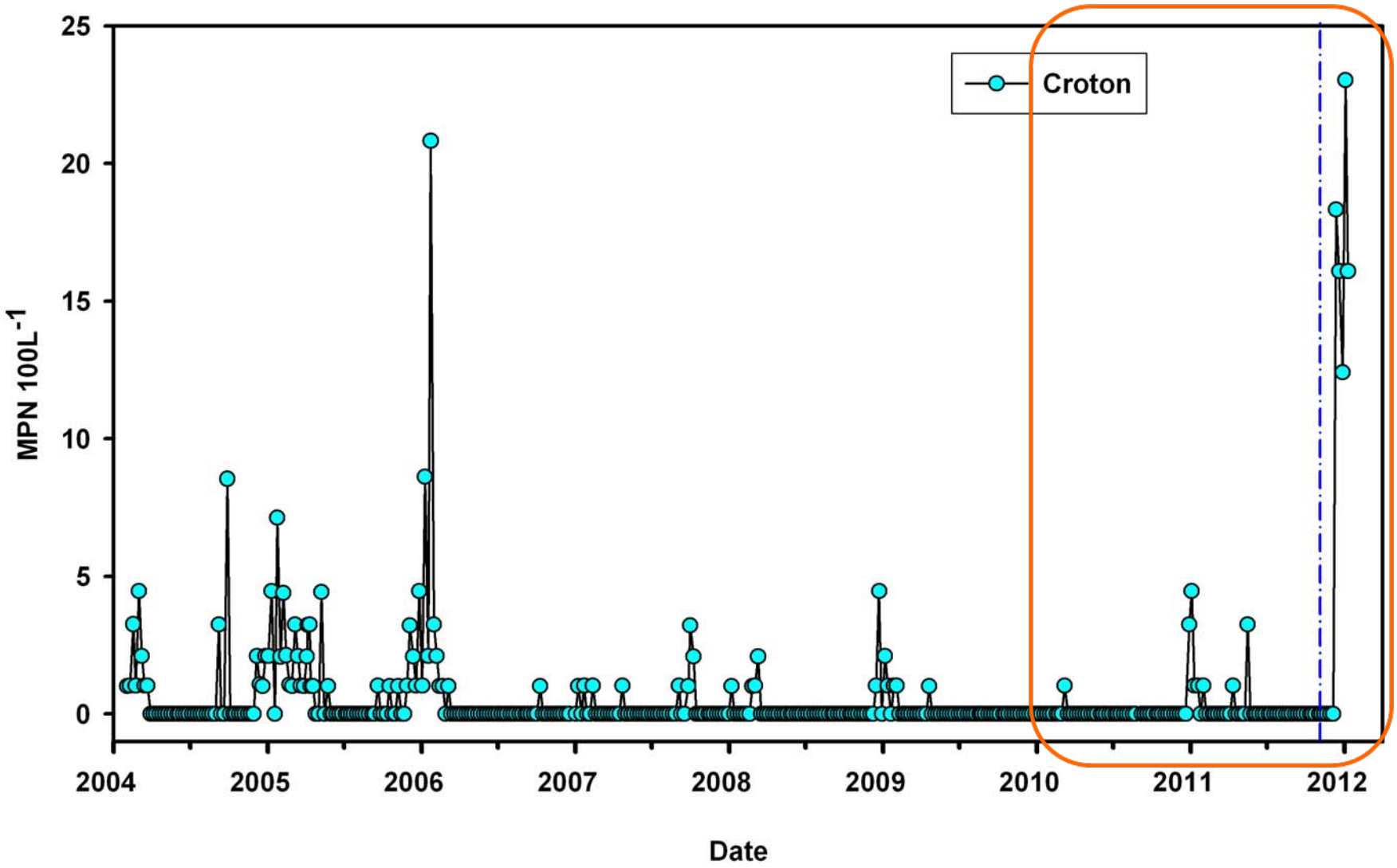


Croton Effluent HEV Results (thru Dec '11)



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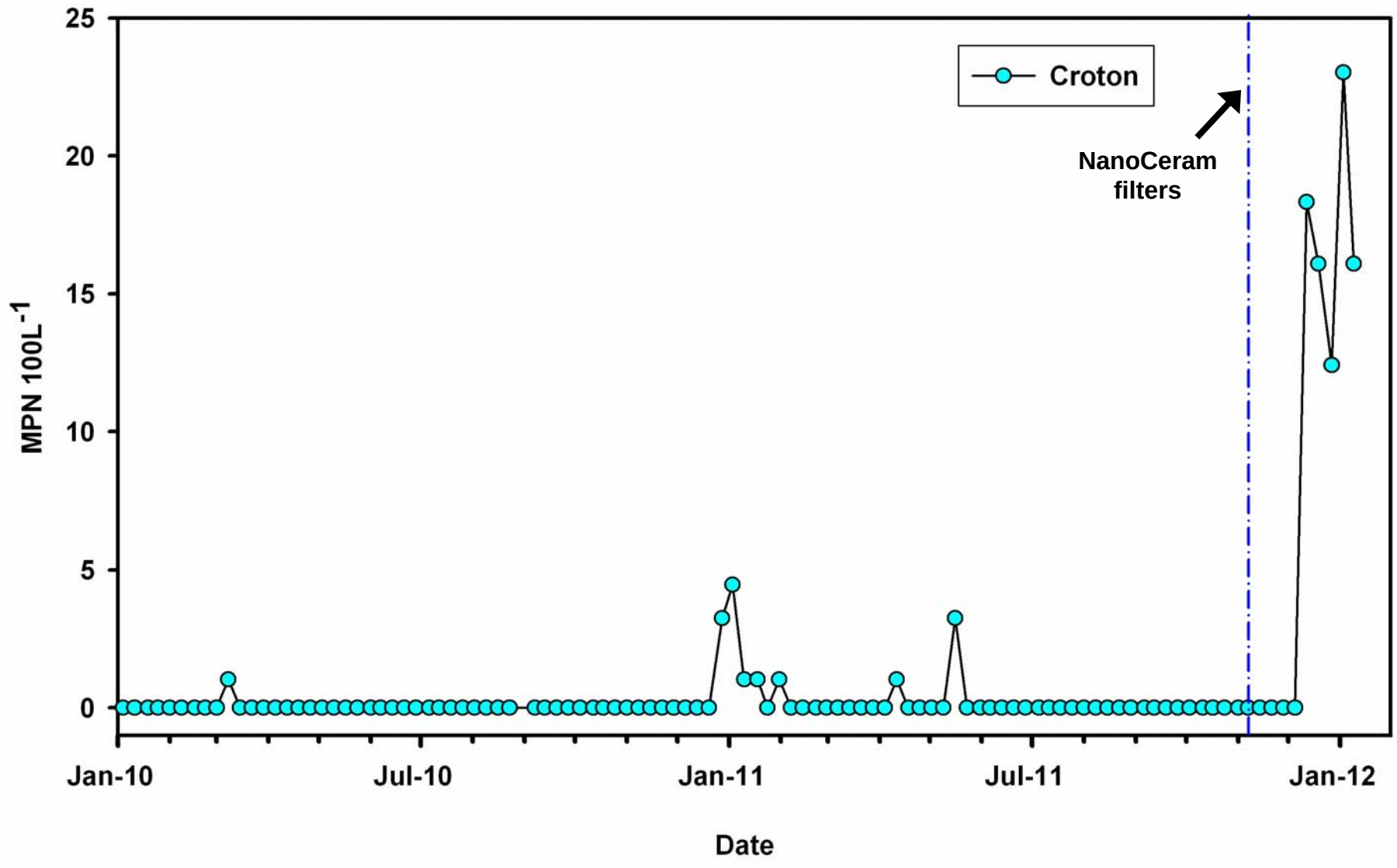


Keypoint HEV Data 2004 - 2010 (thru Jan 3 2012)

n approx 416

Site	n	Mean MPN/ 100L	Updated Mean	Max	95th % tile	Updated 95th %tile
CATALUM	362	1.44	1.34	49.62	6.99	5.75
DEL17*	362	0.63	0.60	11.96	3.25	3.25
CATLEFF	364	0.44	0.50	44.3	2.09	2.11
DEL18	336	0.27	0.34	7.14	2.09	2.11
CROGH*	362	0.47	0.64	20.82	3.17	3.25

*Or an alternate site sampled as necessary due to reservoir operations

Is this the filter causing the increase?

Additional follow up samples needed

Follow up side by sides

Laboratory HEV results (MPN $100L^{-1}$)

Date	Site	CUNO	NANO 5”
1/3/2012	CATLEFF	9.16	6.93
1/9/2012	DEL18	6.93	4.87
1/17/2012	DEL18	1.04	1.05
1/23/2012	DEL18	0.00	0.00
1/30/2012	DEL18	2.23	0.00
	Mean	3.87	2.57

HEV Stats for All Side by Sides

(n = 18)	CUNO	NANO 5”
Detections	9	7
Concentration (MPN $100L^{-1}$)		
Mean	3.18	1.79
Median	0.52	0.00

50% nondetect

50% tied data

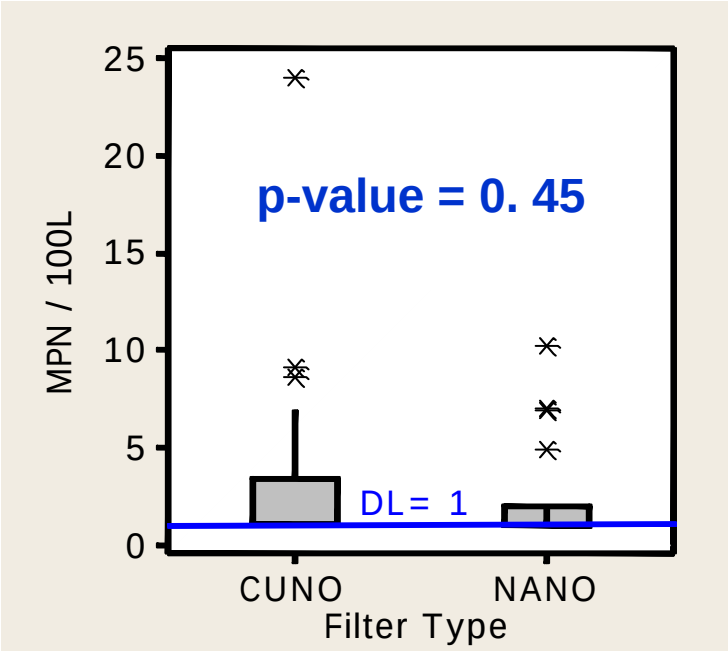
Paired *t*-test

p-value = 0.04

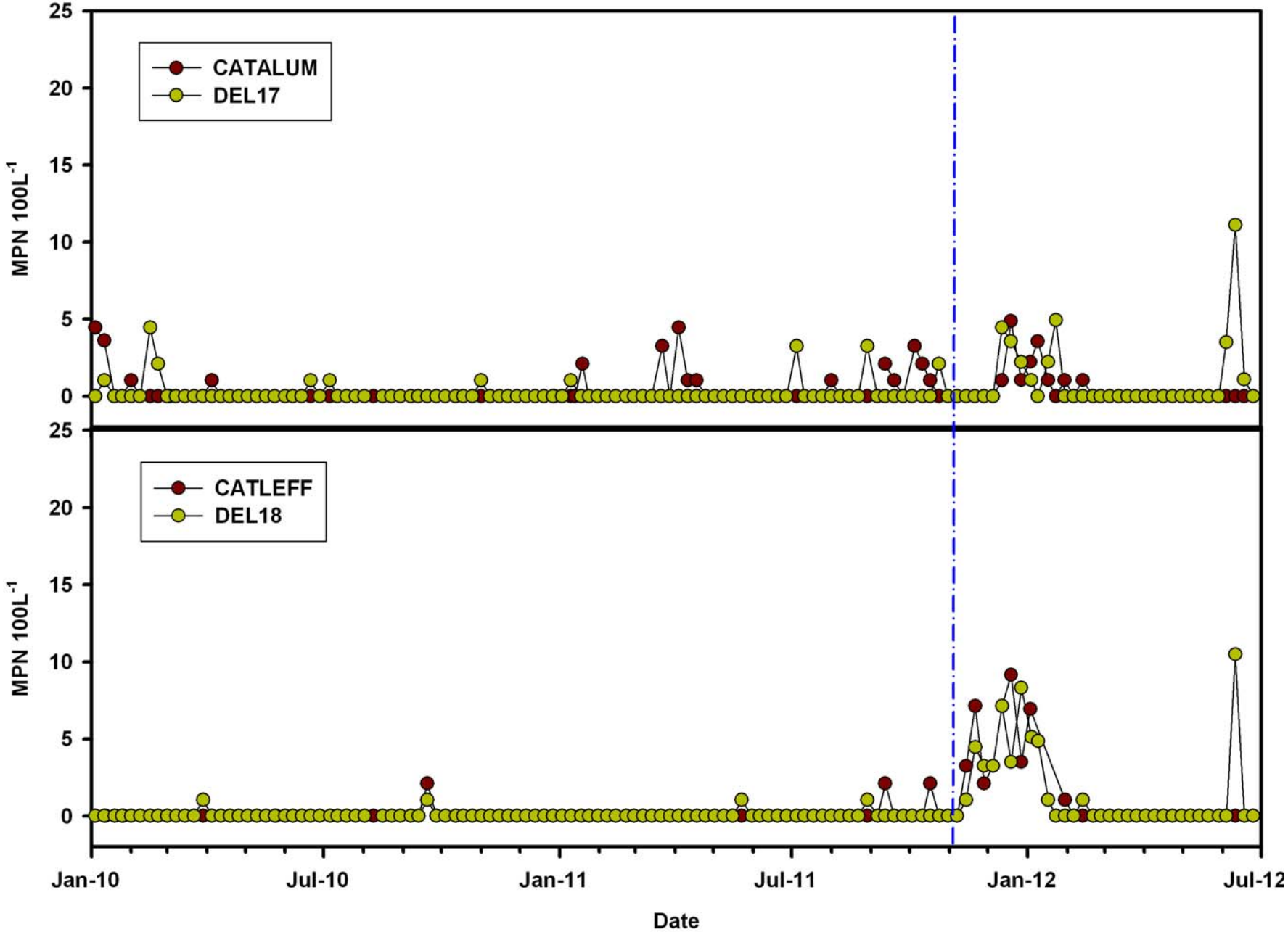
Non-parametric stats are preferred

Modified Sign test
p-value = 0.77

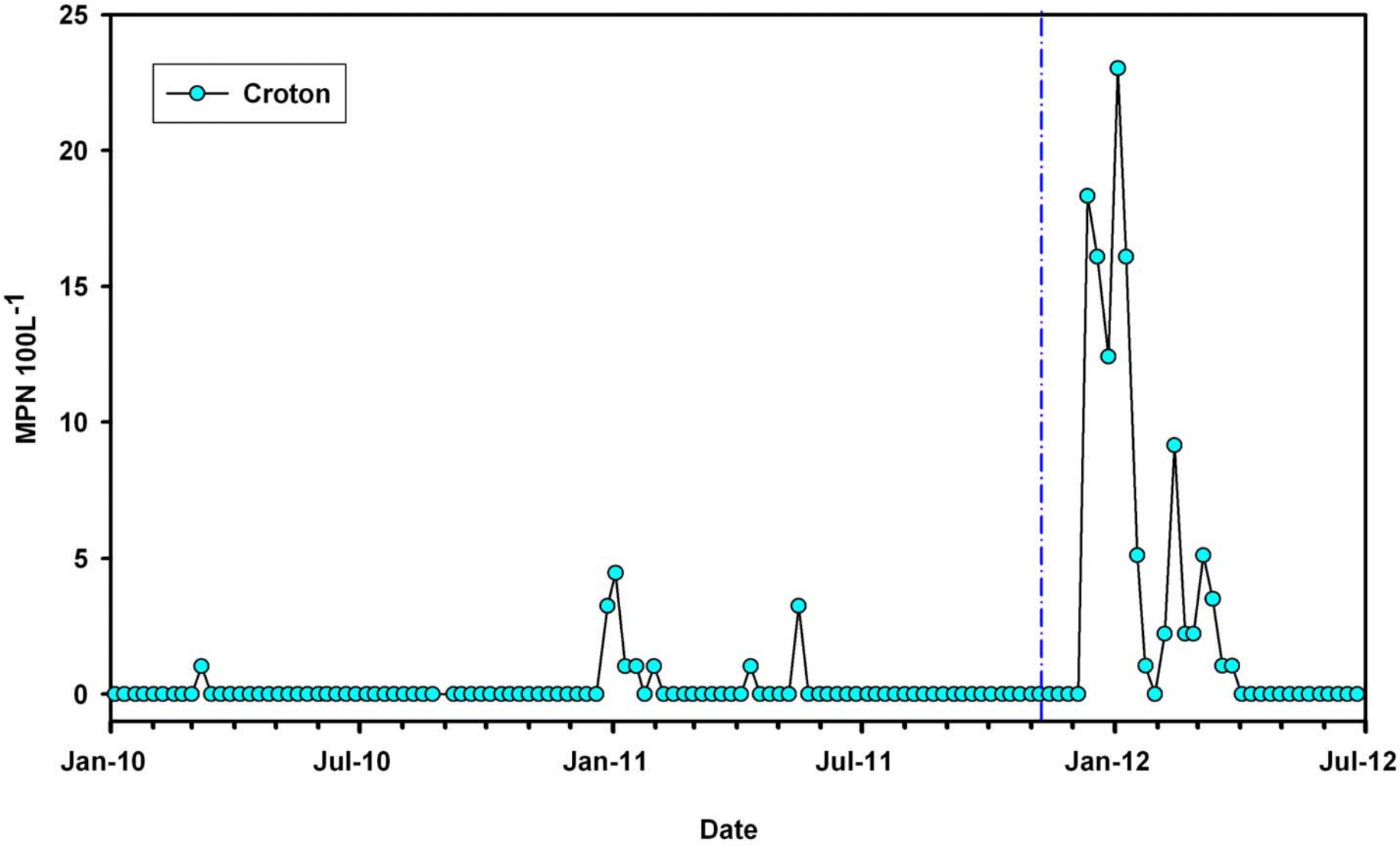
Mann-Whitney test



Kensico Keypoint HEV Data (thru June ’12)



Croton Keypoint HEV Data (thru June ’12)



NanoCeram® – Pressure Issues

DATE	SITE	VOLUME FILTERED (liters)	TURBIDITY (ntu)	CUNO PRESSURE (psi)	NANO 5" PRESSURE (psi)
3/26/12	CATALUM	244	14.49	18	
3/26/12	CATLEFF	240	0.70		24
3/26/12	DEL17	240	0.80		20
3/26/12	DEL18	240	0.98		28

- High turbidity at CATALUM, pressure with CUNO only 18psi
- Low turbidities at other sites, Nano 5" approaches max pressure
- Important to slow the flow to keep pressure < 30psi
- Practicality of low flow rate (240L / 5LPM = 48 Minutes)
- Nano 10" filter might help resolve pressure

NanoCeram® 10” Trials

Pressures recorded during sampling

Date	Site	Turbidity	CUNO (psi)	NANO 10” (psi)
4/30/2012	DEL17	0.9	10	8
5/7/2012	DEL17	0.9	22 (NANO 5”)	14
4/30/2012	CATALUM	5.2	9	4
5/7/2012	CATALUM	3.9	6	8
5/14/2012	CATALUM	5.2	11	12
	Mean (n = 4)		9	8

All samples were negative for HEVs

Current Status

- NanoCeram 5” at all sites (as of June 4, 20112)

- Pressure remains an issue requiring:
  - Additional attention to flow rate
  - Longer sample times

- High turbidity samples = >1 NanoCeram 5” filter (or NanoCeram 10”)

Conclusions

- Argonide NanoCeram® were found to be comparable to CUNO Virosorb© filters
- Cost savings of 67% in annual filter costs
- Greater attention required to pressure and flow rates with NanoCeram 5” filter
- Additional side by side samples warranted for streams
  - Investigate small differences in filter performance for environmental viruses vs. lab material

Virus Field Filter Comparison

Thank you!