NBC Receiving Water Monitoring Initiatives & Data Update

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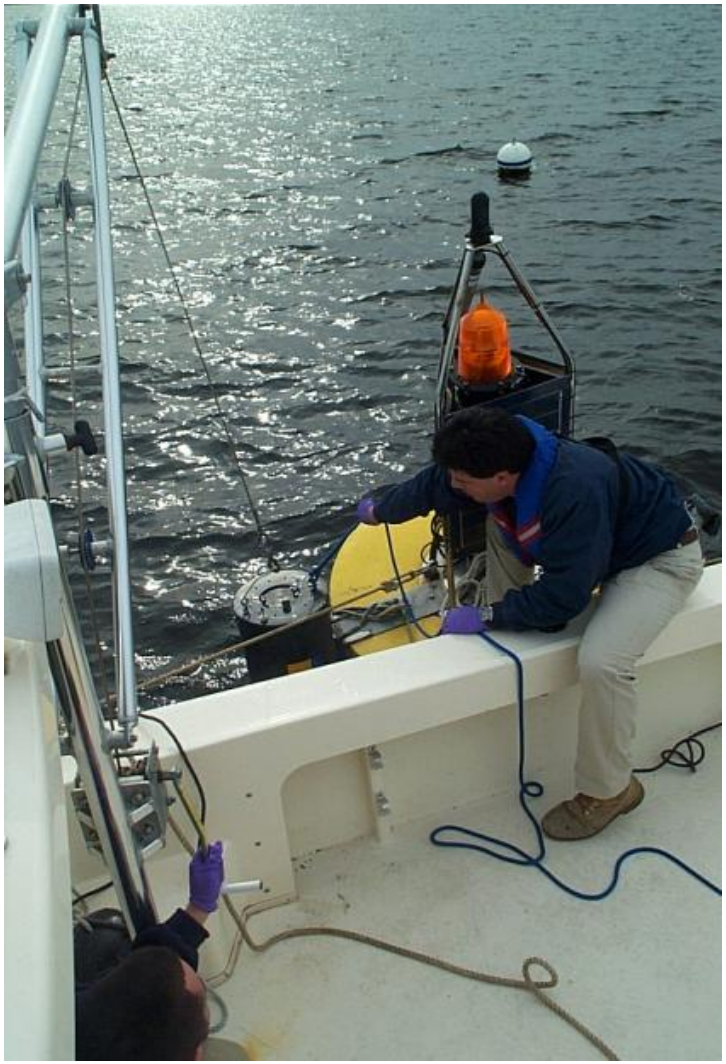
Narragansett Bay Commission

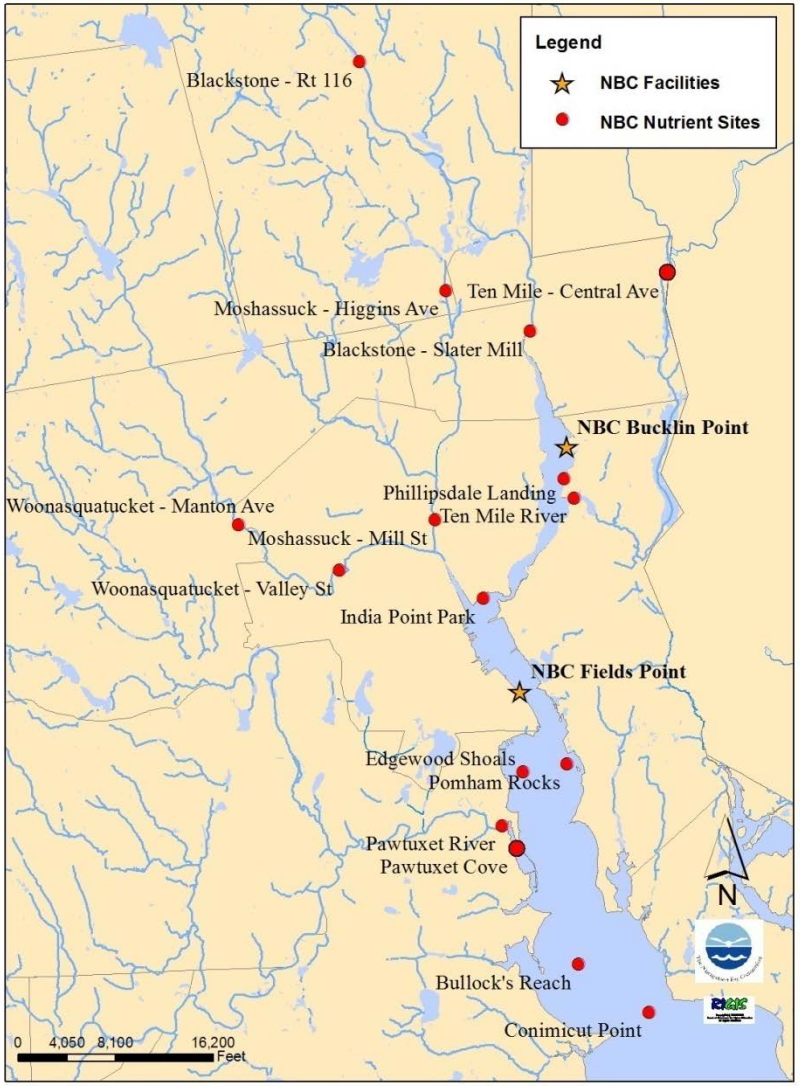
Fixed Site Monitoring Initiative

- NBC Maintains automated on-line monitoring at 2 fixed positions:
  - ✓ Phillipsdale Landing in Seekonk River, E. Prov
  - ✓ Buoy at Bullock's Reach in Providence River
- Real-time data measurements for D.O., Temp, Salinity, pH, Chlorophyll, Turbidity and Tidal Cycles
- Provide continuous public access to data via NBC website
- Use YSI Sondes to monitor surface & bottom at both sites & mid depth at Bullocks Reach



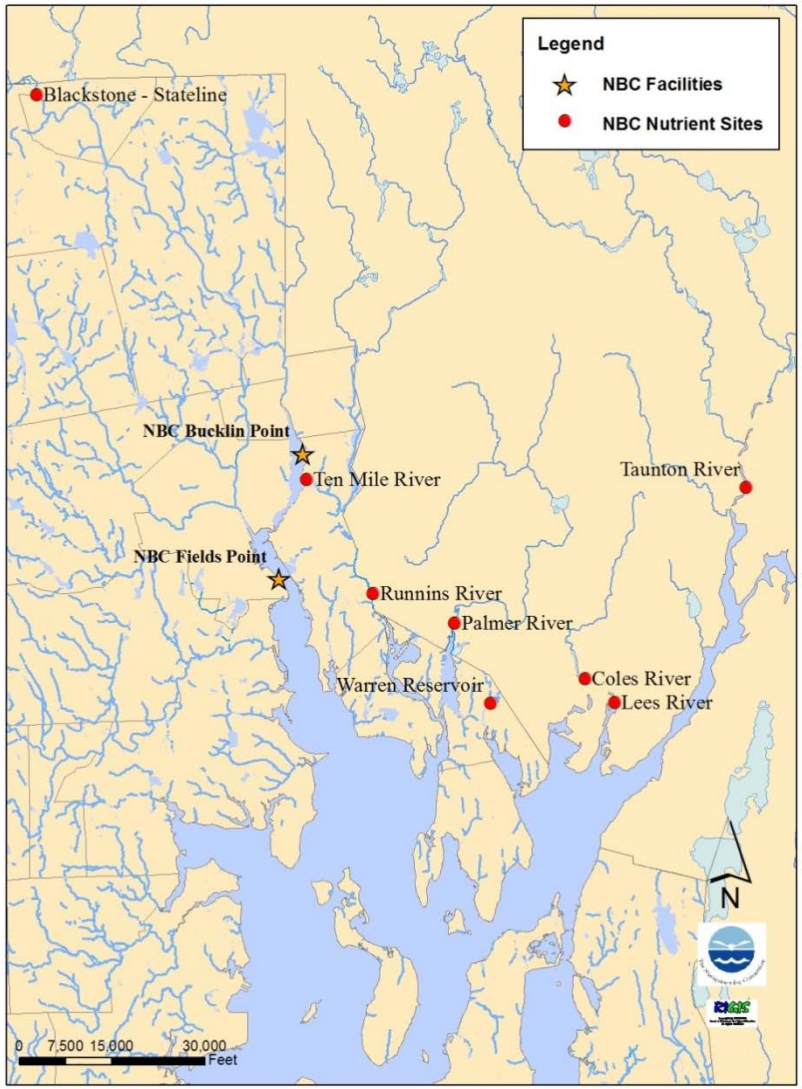
Upper Bay and Tributary River Nutrients Monitoring Initiative

- Monitor nutrients in Providence, Seekonk Rivers and their tributaries
- Frequency varies from once to twice per month to weekly at some sites during summer season
- Evaluate nutrient loading sources in all weather conditions
- Provides important data for development of NBC funded ROMS model of upper bay



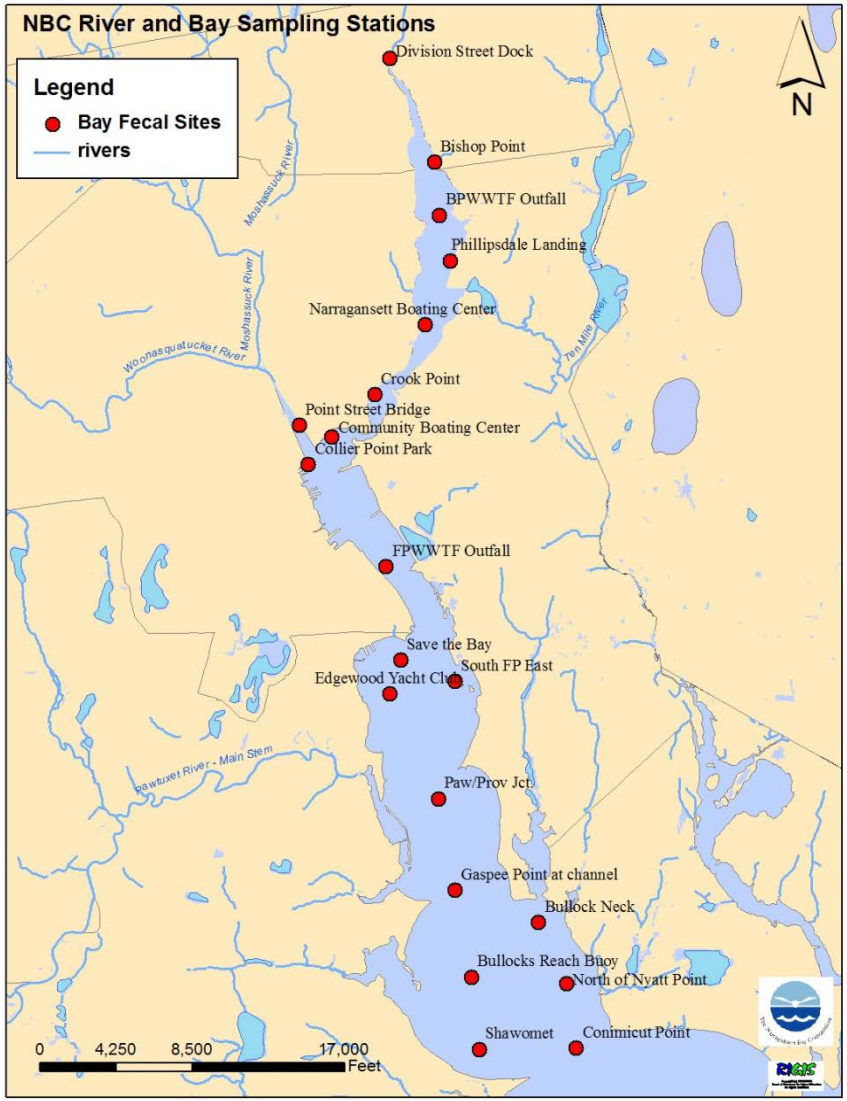
State Border Nutrients Monitoring Initiative

- Sample tributaries monthly that originate from outside RI
- Sites include Ten Mile, Runnins, Palmer, Warren Res., Cole, Lee, Taunton and Blackstone Rivers at state line.
- Data used to evaluate Nitrogen loading sources and success of reductions by WWTFs



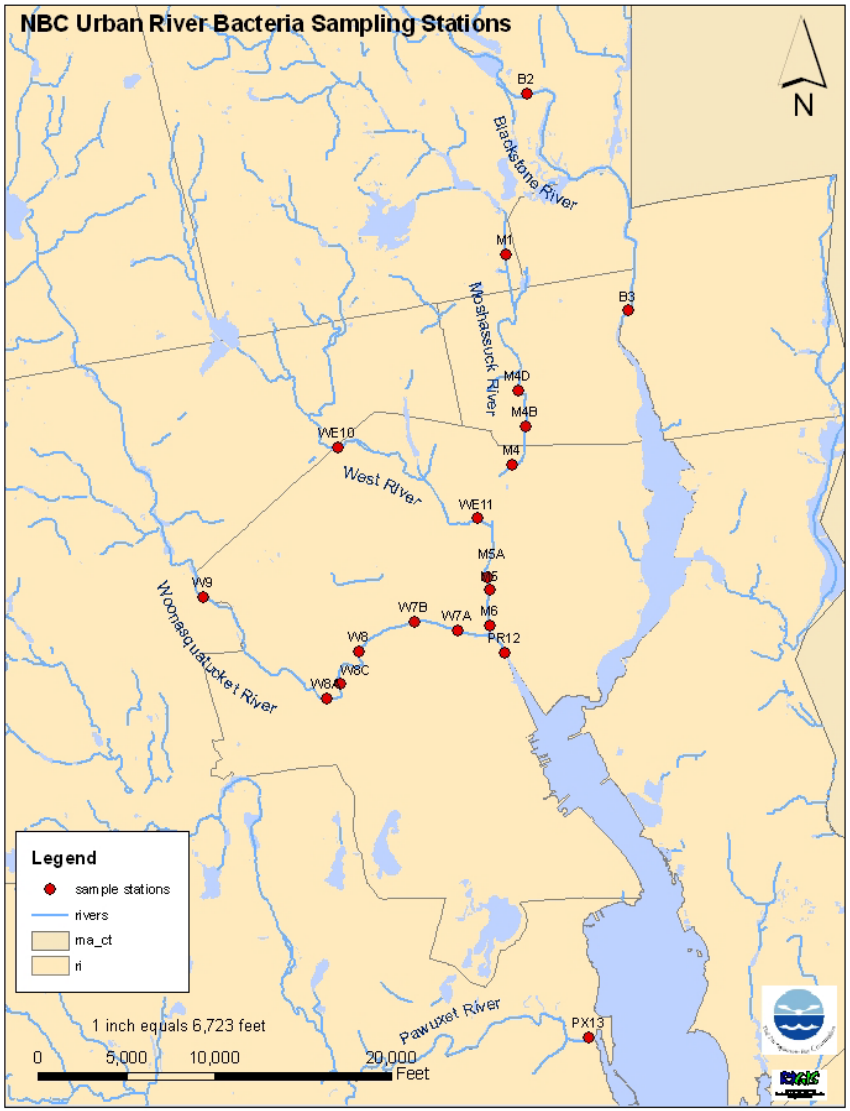
Bay Bacteria Monitoring Initiative

- Sample 20 sites for Bacteria in Providence and Seekonk Rivers every other week
- Samples analyzed for fecal coliform
- 25% of samplings also analyzed for enterococcus
- Sample several storm events annually to evaluate bay water quality improvements (CSO tunnel)
- Periodically sample shellfishing areas in cooperation with DEM



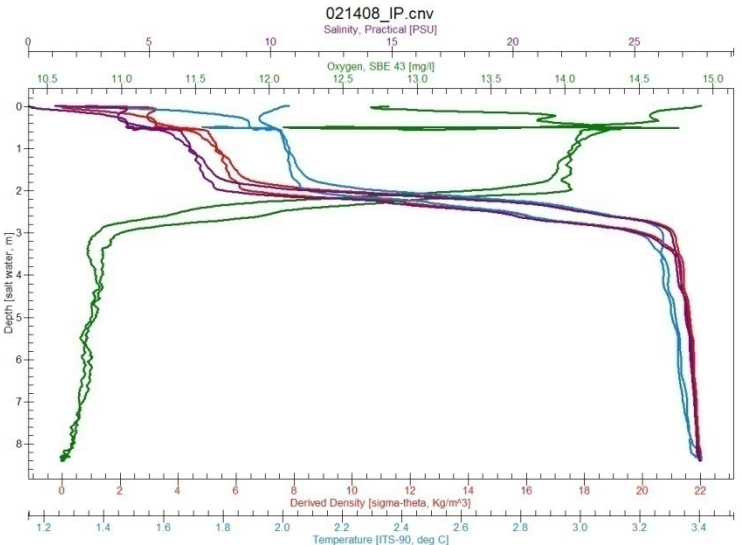
River Bacteria Monitoring Initiative

- 19 Urban CSO affected river stations sampled twice weekly
- Element of NBC Nine Minimum CSO Controls Program (RIPDES)
- Mouth of Pawtuxet River also sampled
- Samples analyzed for fecal coliform, with some enterococcus analyses



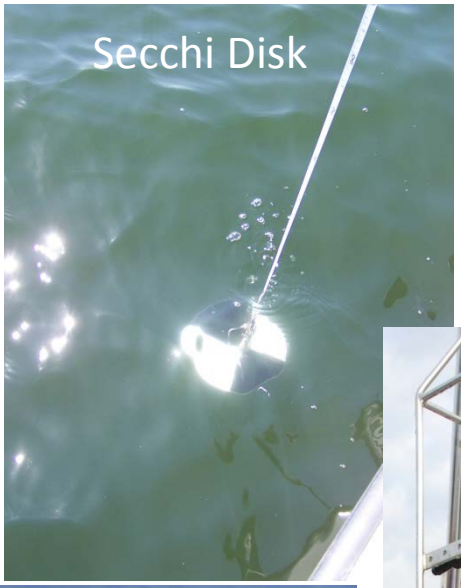
Water Quality Profiles

- Utilize Seabird Profiler
- 6 Bay Stations
- Measures water parameters throughout water column
- Insomniacs perform this test during poorest water quality periods- We do it routinely!!!
- Conducted weekly during summer & alternating weeks rest of the year
- Allows us to identify causes of hypoxia, show complete picture



Water Clarity Monitoring

- Water clarity measured multiple ways:
  - ✓ Secchi disk collected at 6 Bay Stations bi-monthly to weekly
  - ✓ Photosynthetic active radiation (PAR) measured with WQ profiles
  - ✓ Total Suspended Solids (TSS) collected with nutrients (Bi-monthly)
  - ✓ Turbidity sensor on bottom sonde at Bullock's Reach measuring continuously



PAR Deck Sensor

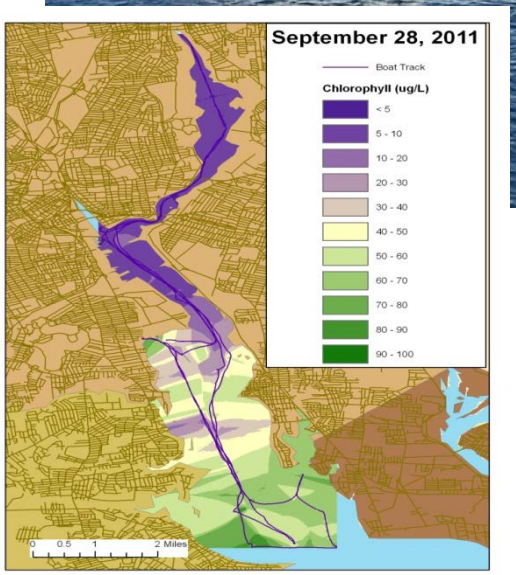
Underwater PAR sensor

Real-Time Mapping of Surface Water Quality in Upper Narragansett Bay

- Use YSI sonde flow-through system to continuously measure surface water quality while boat is underway
- Computer program integrates GPS coordinates and depth finder data with water quality data sets
- GIS spatial analyst software is used to generate mapping rasters
- Create surface water quality maps for dissolved oxygen, chlorophyll, temp…

Surface Water Mapping

- Conduct mapping weekly in summer whenever vessel is underway monitoring
- Allow identification & tracking of algae blooms
- Provides a great picture of what is happening in surface waters
- Hope to join forces with NBNERR to cover larger area of Bay



Benthos Monitoring

Quad Rig

Seekonk River
04/04/2012

Providence River
South of Save the Bay
04/04/2012

Tow Sled

Long-term trends will track impact of nutrient reductions upon benthos

Providence River
North of Conimicut Point
11/07/2012

Plankton Monitoring Initiative

- Quantitative & qualitative assessment of phytoplankton population
- Bi-monthly sample collection at Bullock's Reach (chlorophyll co-sampled & available real-time)
- Collected with full nutrients suite
- Detail species composition shifts in response to WWTF upgrades
- Completed with support of
  - ✓ Bay, Rivers & Watersheds Coordination Team
  - ✓ URI-GSO

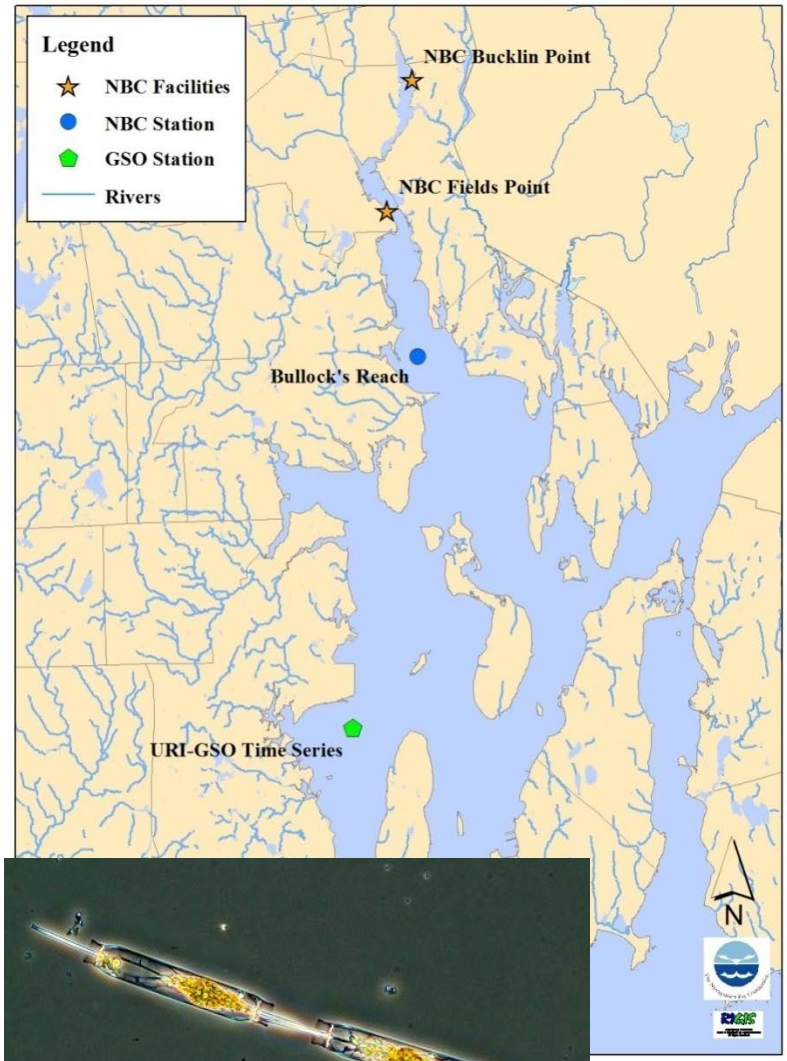
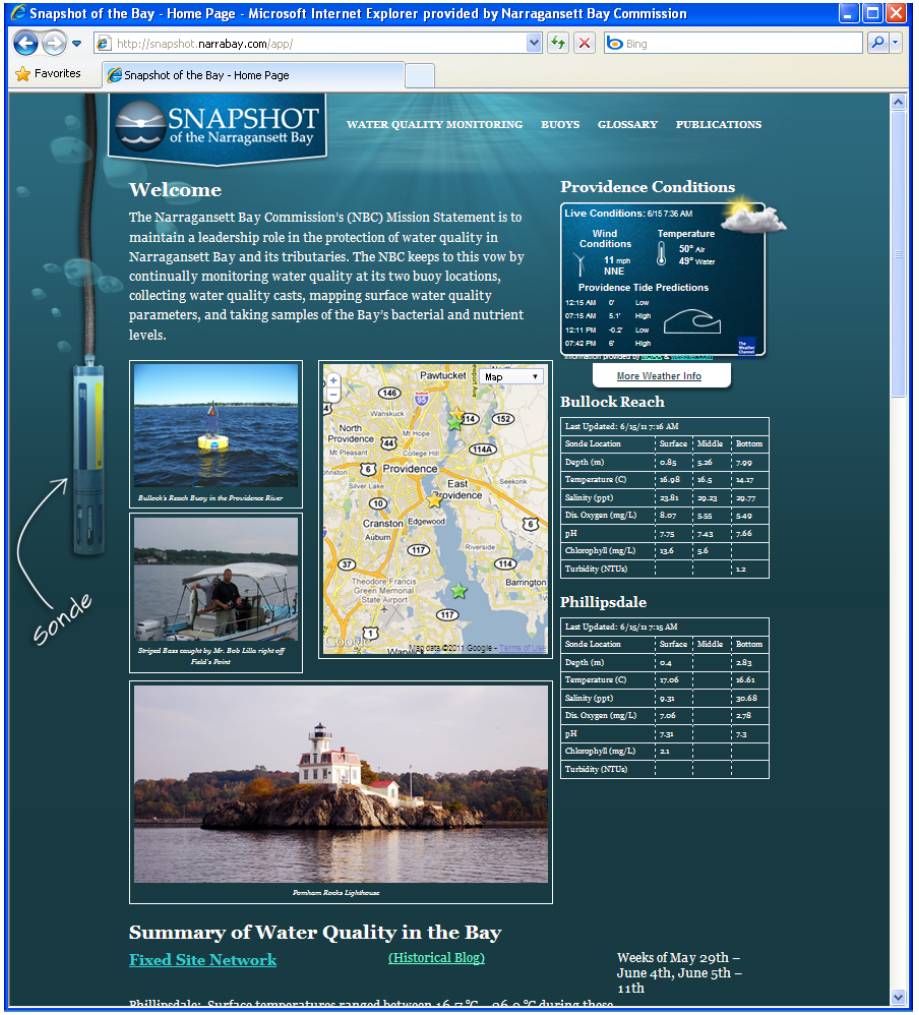


Image of *Ditylum* species using 200x phase contrast

“Snapshot of Upper Narragansett Bay”

- NBC Water Quality Webpage
- Data available promptly for Stakeholders, Regulators, Universities & General Public
- New information & functionality will be added to the site
- National Association of Clean Water Agencies (NACWA) recognized website for excellence in e-media education
- *Visit www.narrabay.com*



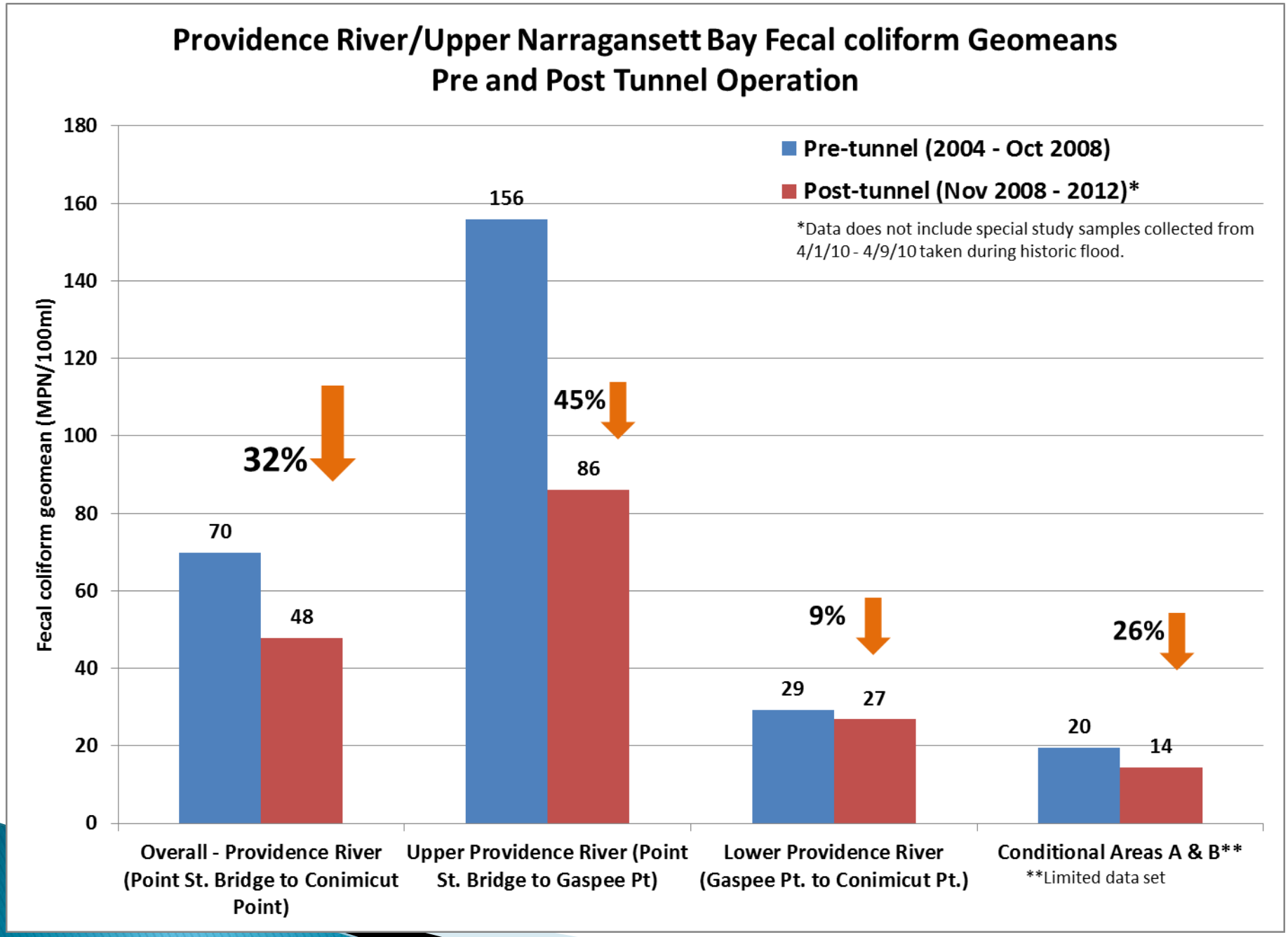
Water Quality Monitoring Findings

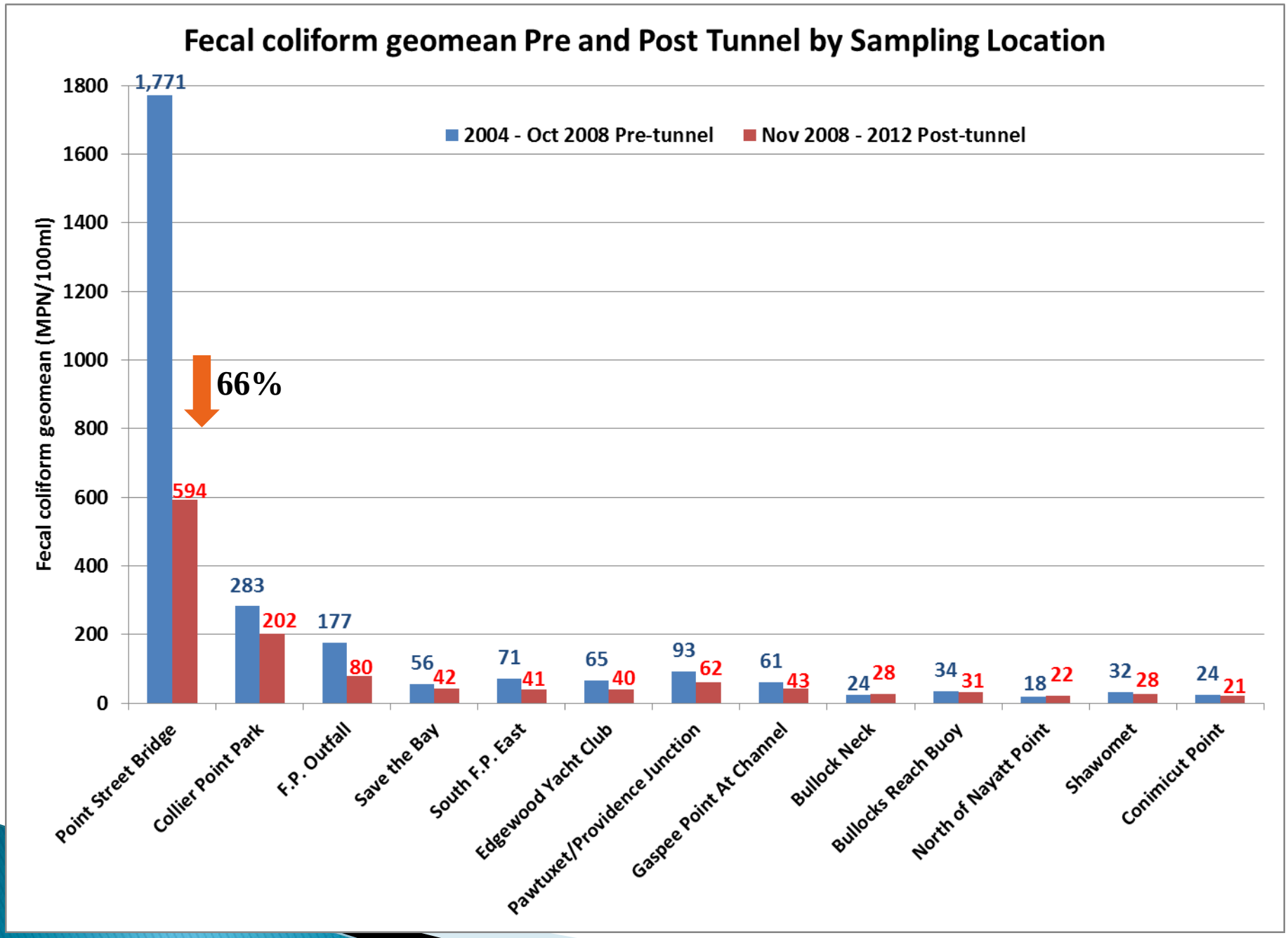
CSO Abatement Project Goals

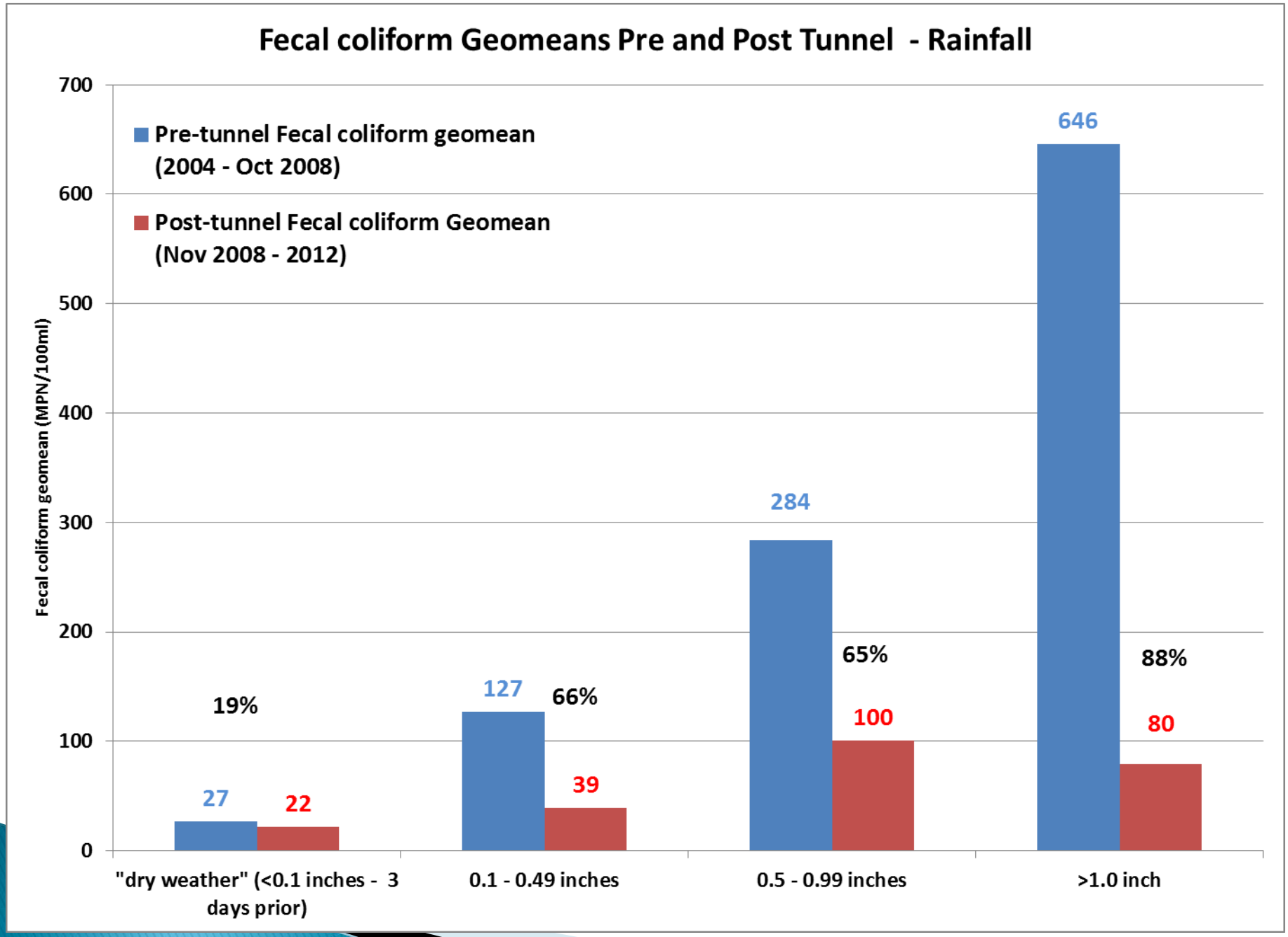
- 98% reduction in annual volume
- 80% reduction in shellfish bed closures
- Designed for a 3 month storm, 1.65” rain in 6 hour period
- Overflows will still occur during larger or more intense storms

CSO Phase I Achievements

- Model estimates 2.2 Billion Gallons of CSO Flow annually
- Phase I CSO Tunnel Capturing 1.1 Billion Gallons annually (50%)
- 4.9 Billion Gallons Captured and Treated since 11/2008
- Significant Water Quality Improvements in Bacteria Contamination have been realized


Providence River/Upper Narragansett Bay Fecal coliform Geomeans
Pre and Post Tunnel Operation
Pre-tunnel (2004 - Oct 2008)
Post-tunnel (Nov 2008 - 2012)*
*Data does not include special study samples collected from 4/1/10 - 4/9/10 taken during historic flood.
Fecal coliform geomean (MPN/100ml)
180
160
140
120
100
80
60
40
20
0
70
48
32%
156
86
45%
29
27
9%
20
14
26%
Overall - Providence River (Point St. Bridge to Conimicut Point)
Upper Providence River (Point St. Bridge to Gaspee Pt)
Lower Providence River (Gaspee Pt. to Conimicut Pt.)
Conditional Areas A & B**
**Limited data set


Fecal coliform geomean Pre and Post Tunnel by Sampling Location
Fecal coliform geomean (MPN/100ml)
2004 - Oct 2008 Pre-tunnel
Nov 2008 - 2012 Post-tunnel
66%
1,771
594
283
202
177
80
56
42
71
41
65
40
93
62
61
43
24
28
34
31
18
22
32
28
24
21
Point Street Bridge
Collier Point Park
F.P. Outfall
Save the Bay
South F.P. East
Edgewood Yacht Club
Pawtuxet/Providence Junction
Gaspee Point At Channel
Bullock Neck
Bullocks Reach Buoy
North of Nayatt Point
Shawomet
Conimicut Point


Fecal coliform Geomeans Pre and Post Tunnel - Rainfall
Pre-tunnel Fecal coliform geomean (2004 - Oct 2008)
Post-tunnel Fecal coliform Geomean (Nov 2008 - 2012)
Fecal coliform geomean (MPN/100ml)
700
600
500
400
300
200
100
0
27
22
19%
127
39
66%
284
100
65%
646
80
88%
"dry weather" (<0.1 inches - 3 days prior)
0.1 - 0.49 inches
0.5 - 0.99 inches
>1.0 inch

More Pounds of Pollutants Removed

- From Nov 2008 – 2012, tunnel operation prevented the release of the following pollutants into the Bay:
  - ✓1.6 Million pounds TSS
  - ✓1.1Million BOD
  - ✓111,613 Pounds Nitrogen
  - ✓49,822 pounds of various Metals removed as a result of tunnel operation and thus.

Pollutant	Pounds (estimated)
TSS	1,671,793
BOD	1,067,082
Total Nitrogen	111,613
Aluminum	8,372
Cadmium	69
Chromium	260
Copper	357
Cyanide	184
Iron	39,319
Lead	305
Nickel	113
Silver	111
Zinc	916

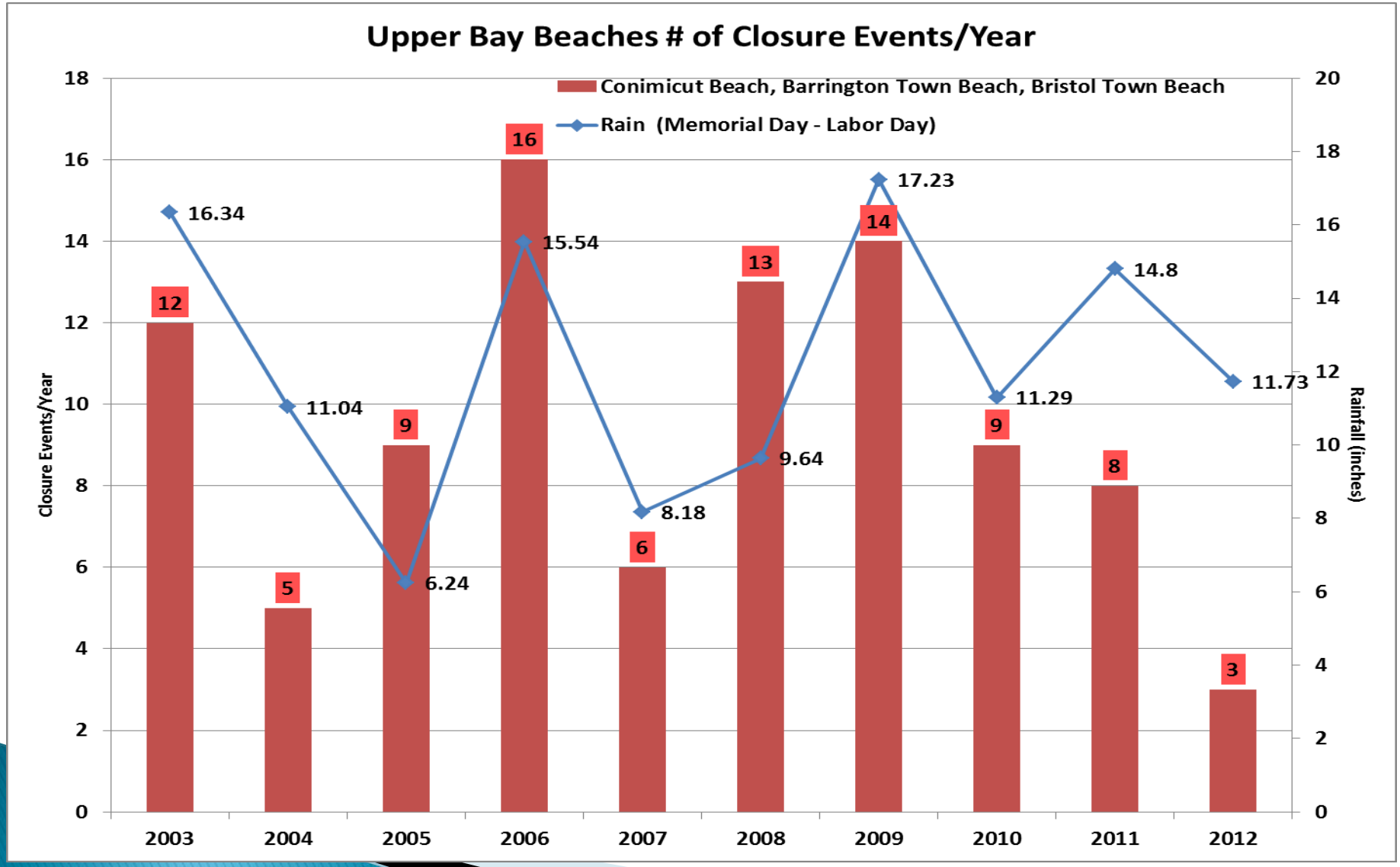
Reduction in Statewide Beach Closures

29 Bay-wide Closure Events in 2012

RIDOH information; Watershed Counts Report 2013

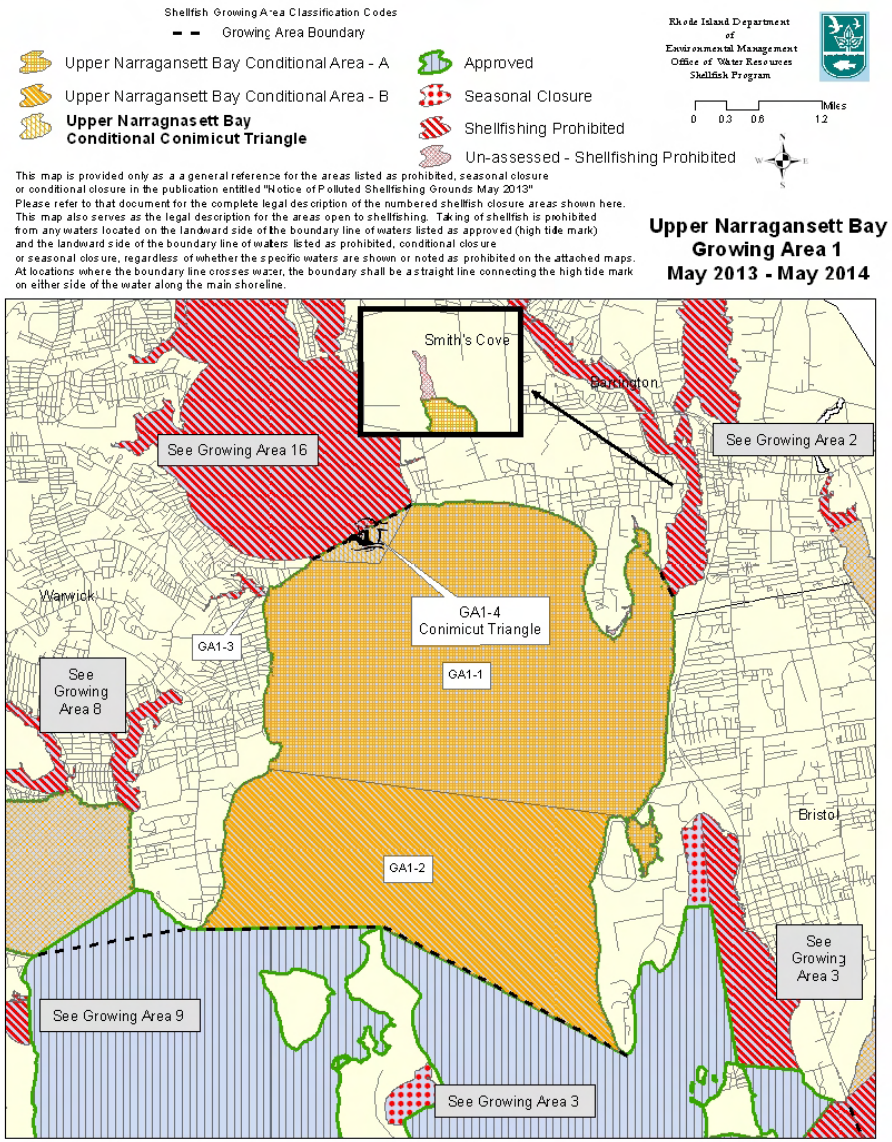
Reduction in Upper Bay Beach Closures

Only 3 Upper Bay Closure Events in 2012



Changes in Shellfishing Regulations

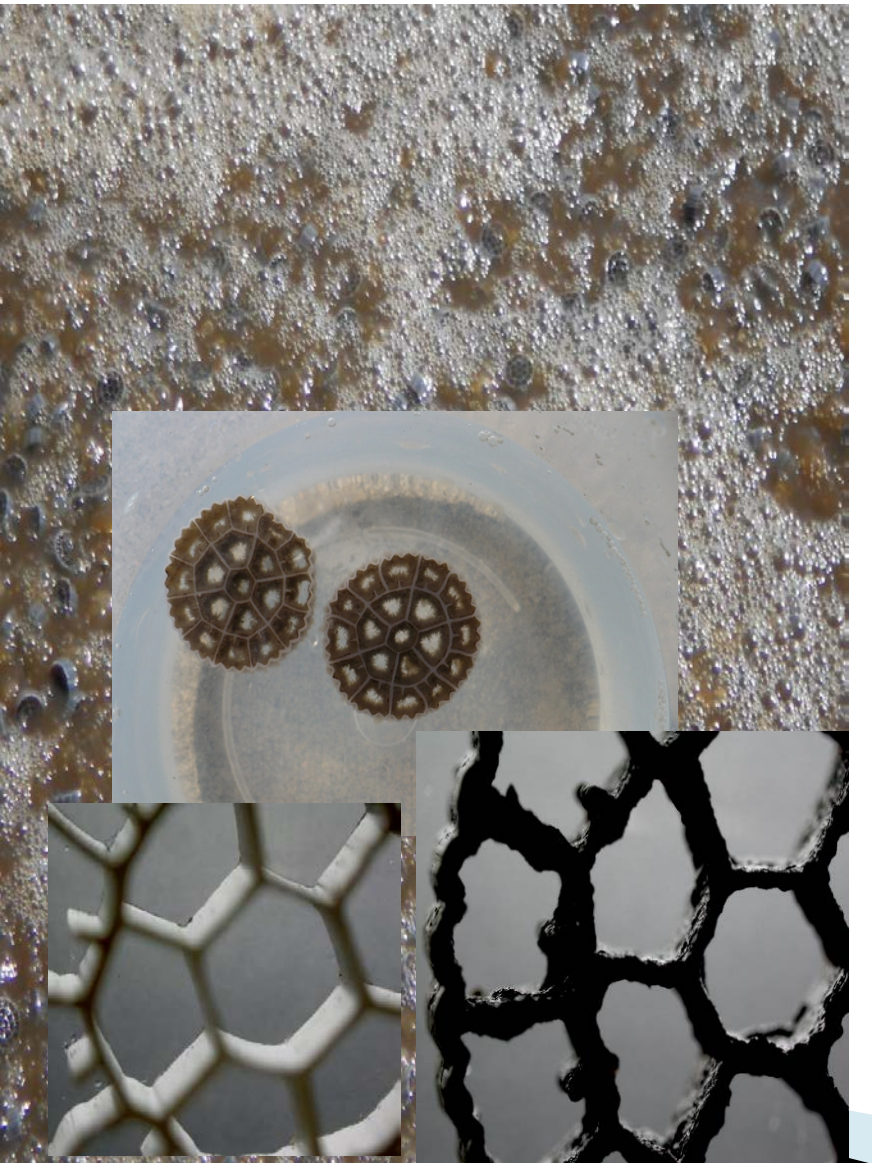
- Area A closes after >0.8” of rainfall in 24 hours
- Area B closes after > 1.5” of rainfall in 24 hours
- Conimicut Triangle area made smaller
- After Phase II, DEM will reevaluate the criteria
- This is important because, in 2012….
  - ✓ 45% of the quahog harvest came from Areas A & B
  - ✓ Totaling 17.5 million clams
  - ✓ Equaling $2.48 million



Summary of CSO Phase I Related Water Quality Improvements

- 4.9 Billion gallons CSO Flow captured
- 32% reduction in bacteria in Providence River
- 66% reduction in bacteria at Point St. Bridge
- 88% reduction in bacteria for a 1 inch storm
- 1.6 million pounds of TSS, 1.1 million pounds of BOD & 112K lbs N captured and removed
- Relaxed Shellfish regulations in Areas A & B
- Decrease in beach closure events at Upper Bay beaches (Only 10% of Statewide Beach Closures in 2012 were in Upper Bay)
- Conimicut, Bristol & Barrington – *3New Bathing Beaches may be coming Soon????) Rocky Point Beach???? Let's hope so!!!!*

Field's Point POTW– Biological Nutrient Removal Upgrade for Total Nitrogen



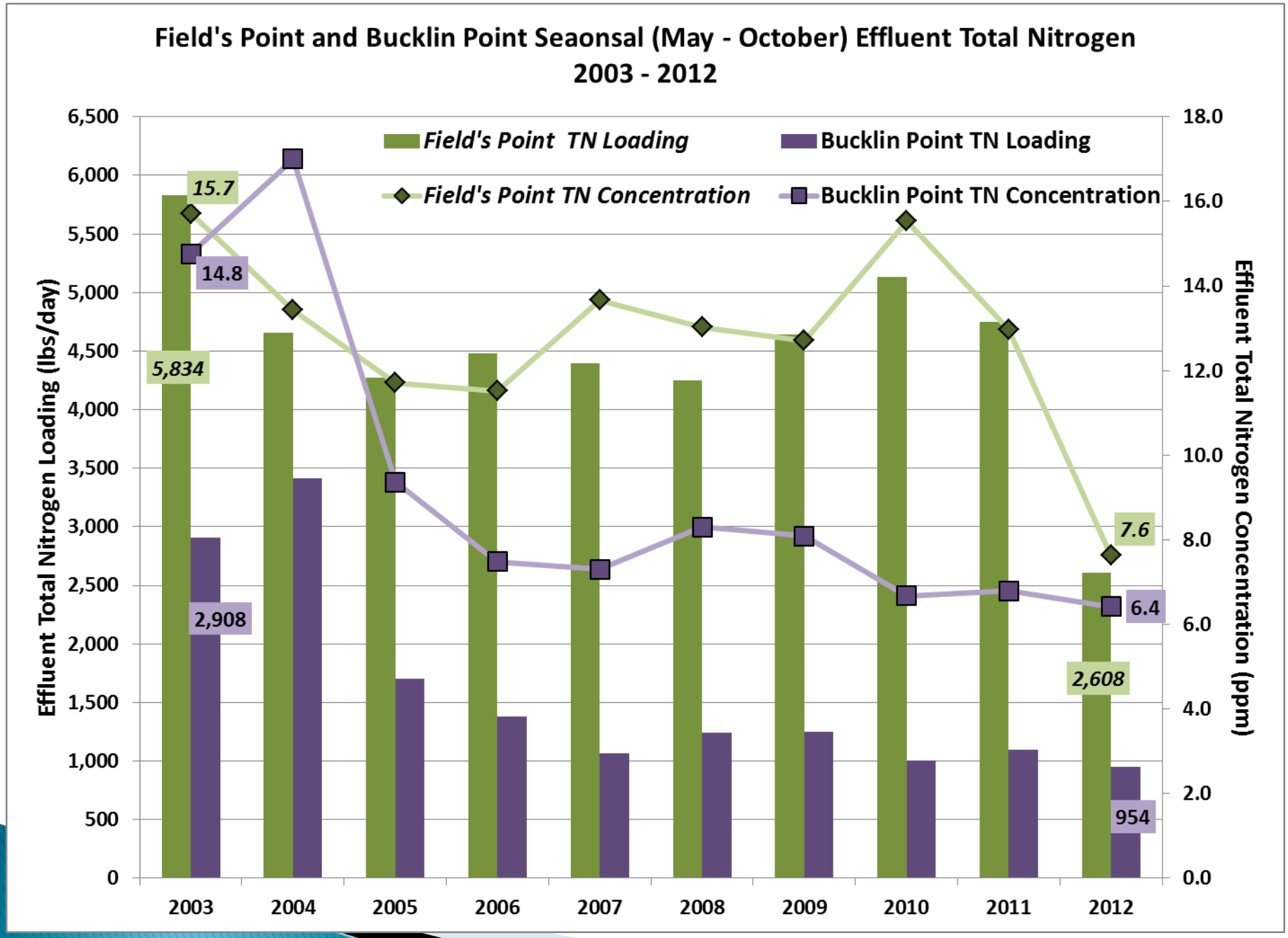
- Will use IFAS system to meet 5 ppm TN – Largest IFAS Plant in World!
- Construction complete at FP, in testing phase
- Permit Limits will be in effect for 2014 season
- Achieved 2012 seasonal average 7.6 ppm TN,4.2 ppm for Aug '12
  - ✓ 13.6 seasonal avg. 2007 – 2011
  - ✓ Already reduced 3,207 lbs TN/day at FP since fish kill based on 2012 data
- 2013 average (Jan – April) 7.0 ppm
  - ✓ April 2013 – 4.1 ppm; May – 3.9 ppm
- Cost – ~$31 million

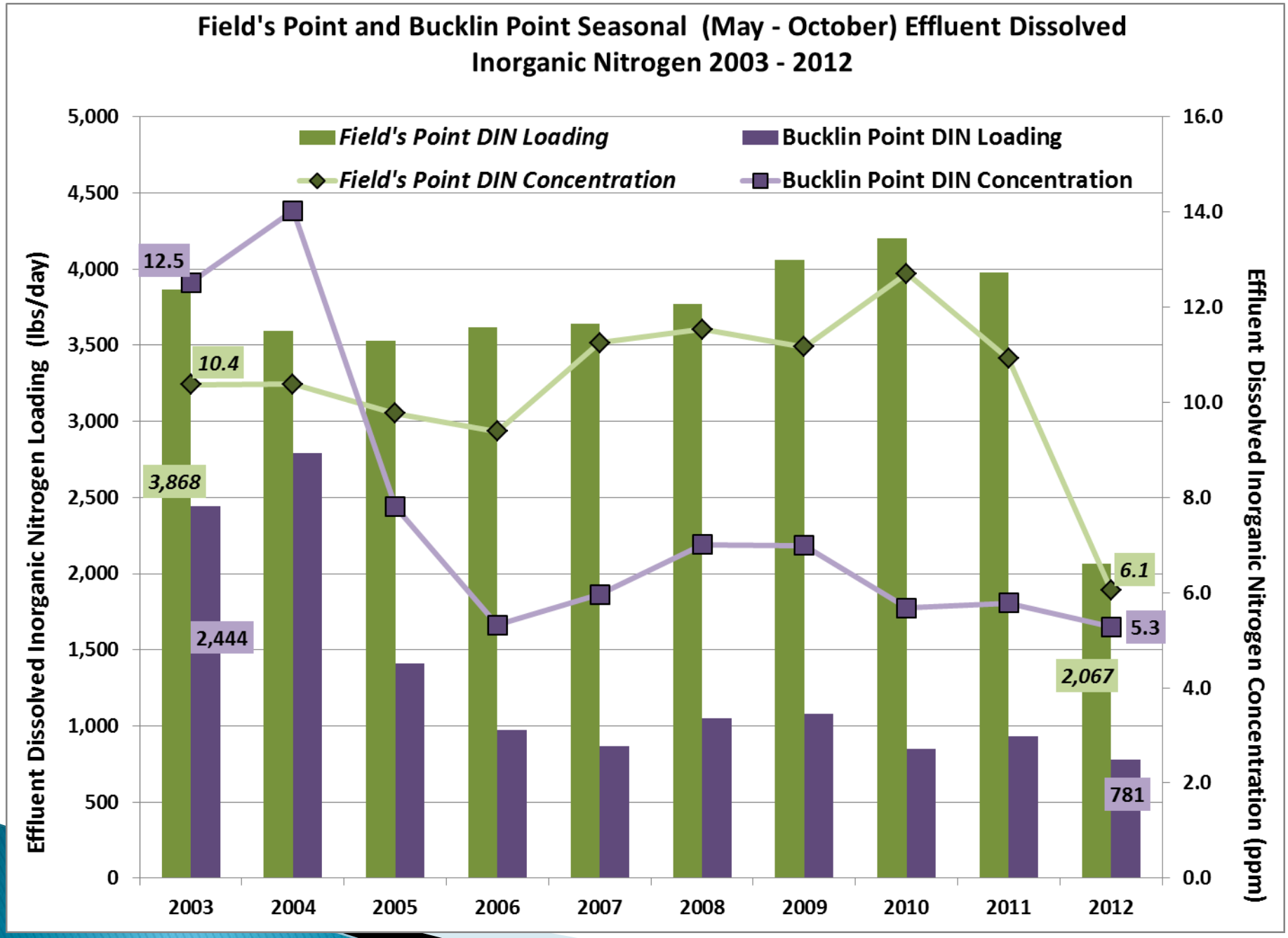
Biological Nutrient Removal Upgrades – Total Nitrogen (TN) – Bucklin Point

- Built to meet 8.5 ppm TN in 2005/2006
  - ✓$8.3 million for initial nitrogen upgrade
- 2012 seasonal average was 6.4 ppm TN
- Upgrade design to 5ppm TN ongoing
  - ✓Estimated cost – $13 million
  - ✓Reduction of ~158 lbs TN/day

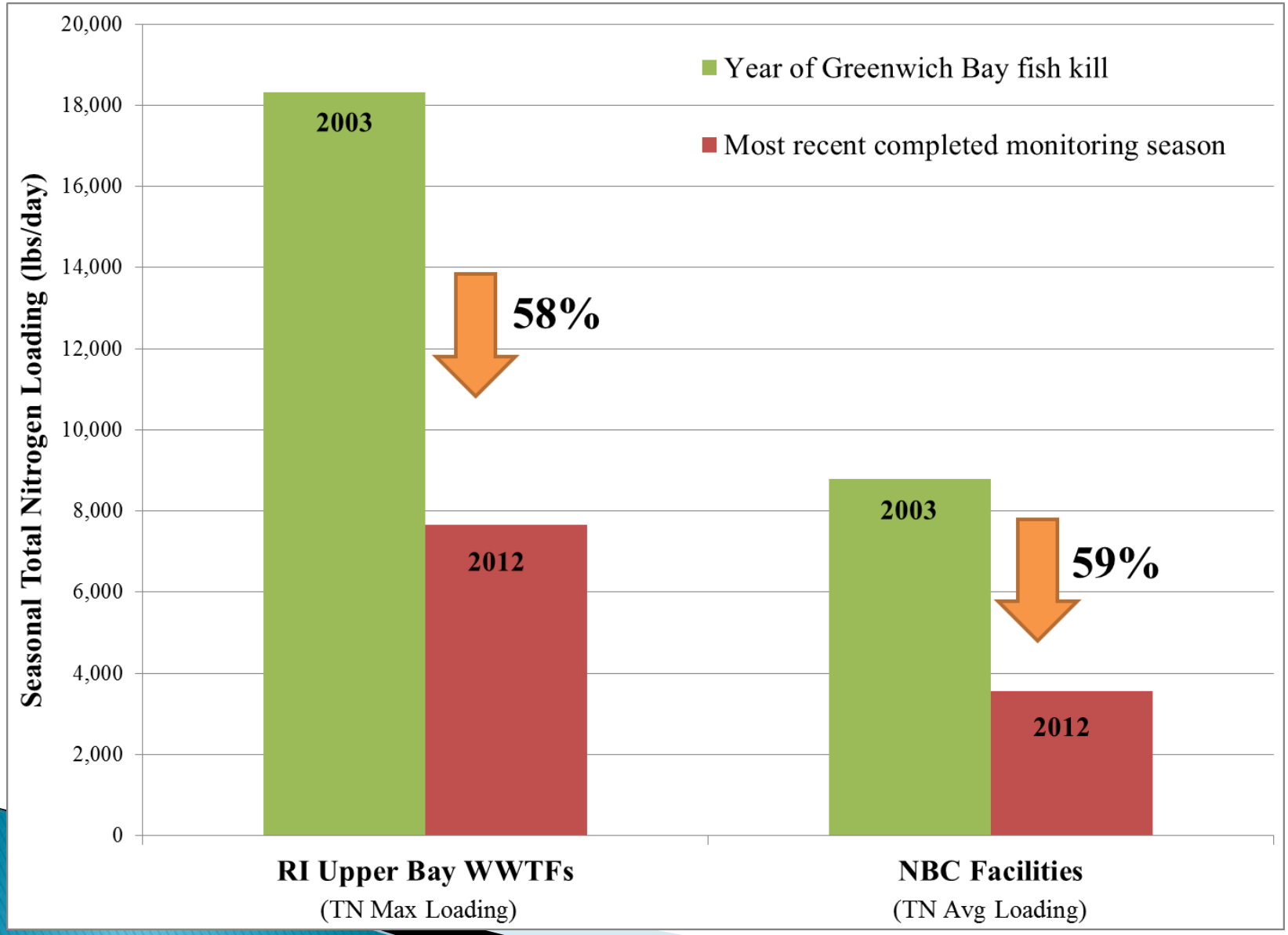
NBC Nitrogen Loading to Upper Bay (May – Oct)

	Concentration (ppm)	Loading (lbs/day)	Percent Reduction (Loading)
Field's Point TN Loading			
Year of the Fish Kill (2003)	15.7	5,834	
May - Oct 2012	7.6	2,627	55%
May 2013 est.	4.0	1,255	78%
IFAS Upgrade	5.0	1,796	69%
If plant achieves 3 ppm	3.0	1,078	82%
Bucklin Point TN Loading			
Year of the Fish Kill (2003)	14.8	2,908	
May - Oct 2012	6.4	964	67%
May 2013 est.	5.8	744	74%
When achieves 5 ppm	5.0	806	72%
If plant achieves 3 ppm	3.0	484	83%
Combined NBC Facilities			
2003	BP=14.8, FP=15.7	8,741	
May - Oct 2012	BP=6.4, FP=7.6	3,591	59%
May 2013 est.	BP=5.8, FP=4.0	1,999	77%
FP&BP Upgrade to 5 ppm	BP=5.0, FP=5.0	2,573	71%
FP&BP Upgrade to 3 ppm	BP=3.0, FP=3.0	1,562	82%

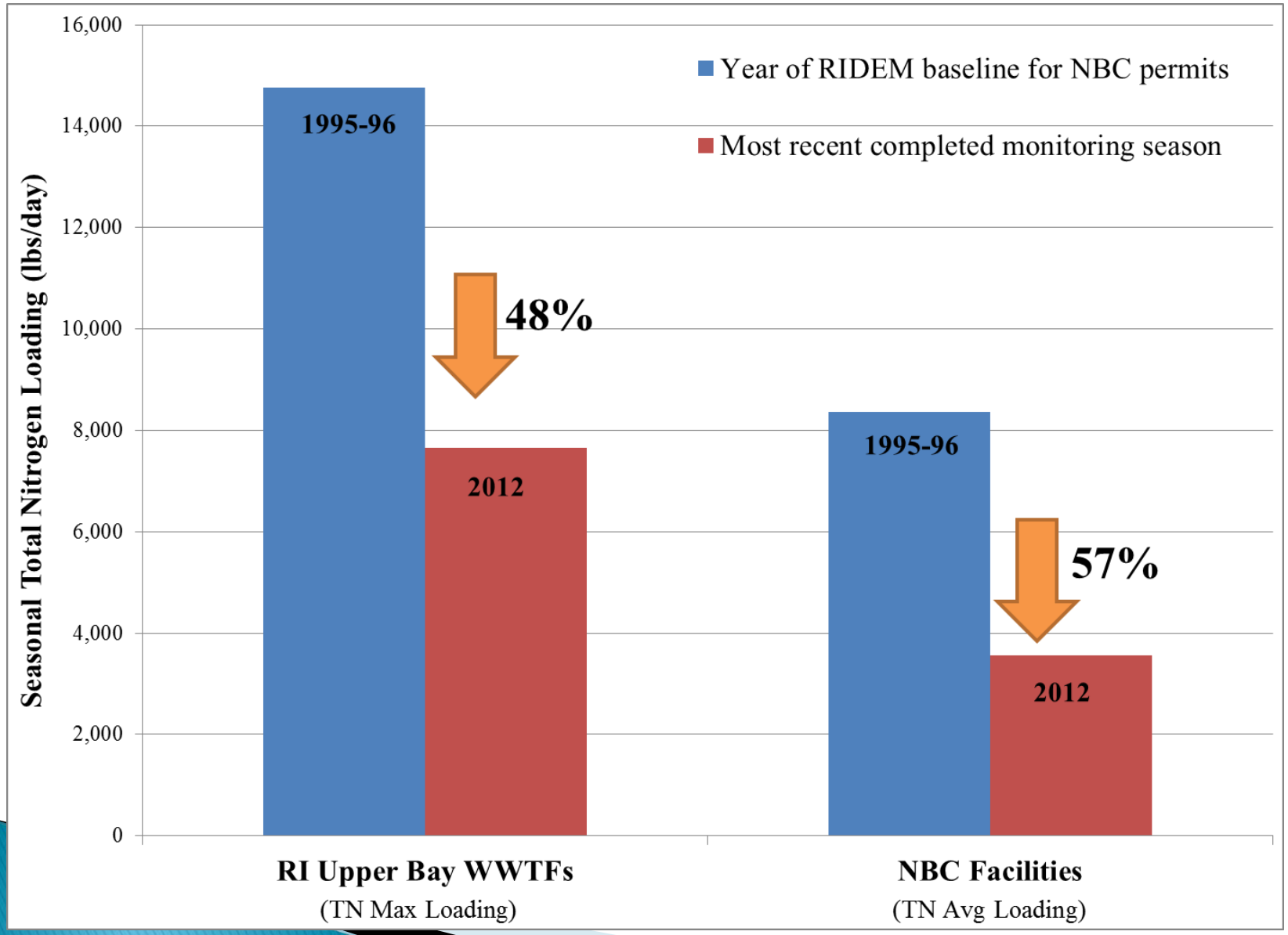

Field's Point and Bucklin Point Seaonsal (May - October) Effluent Total Nitrogen
2003 - 2012
Field's Point TN Loading
Bucklin Point TN Loading
Field's Point TN Concentration
Bucklin Point TN Concentration
Effluent Total Nitrogen Loading (lbs/day)
Effluent Total Nitrogen Concentration (ppm)
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
15.7
14.8
5,834
2,908
7.6
6.4
2,608
954


Field's Point and Bucklin Point Seasonal (May - October) Effluent Dissolved Inorganic Nitrogen 2003 - 2012
Field's Point DIN Loading
Bucklin Point DIN Loading
Field's Point DIN Concentration
Bucklin Point DIN Concentration
Effluent Dissolved Inorganic Nitrogen Loading (lbs/day)
Effluent Dissolved Inorganic Nitrogen Concentration (ppm)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
12.5
10.4
3,868
2,444
6.1
5.3
2,067
781

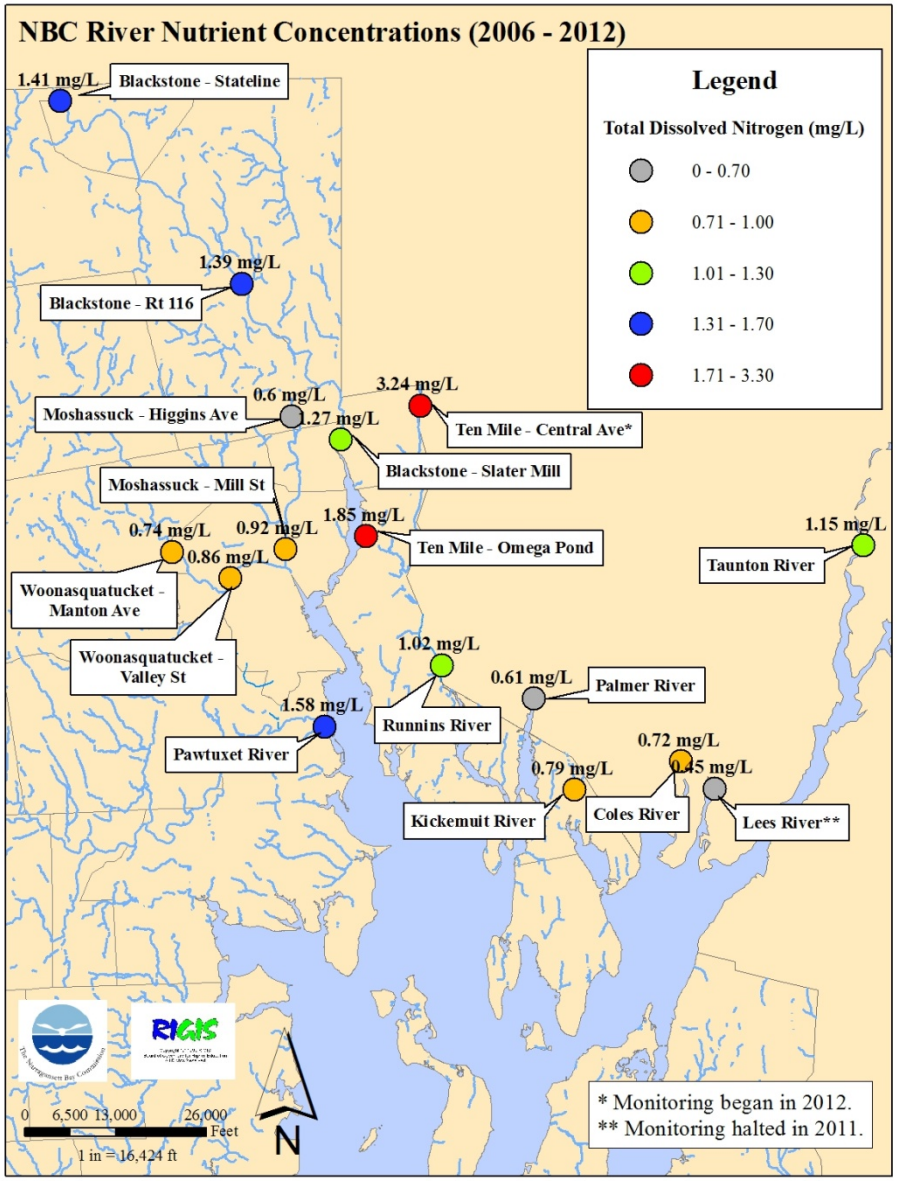
Seasonal Total Nitrogen loading 2003 vs. 2012



Seasonal Total Nitrogen loading 1995-96 vs. 2012

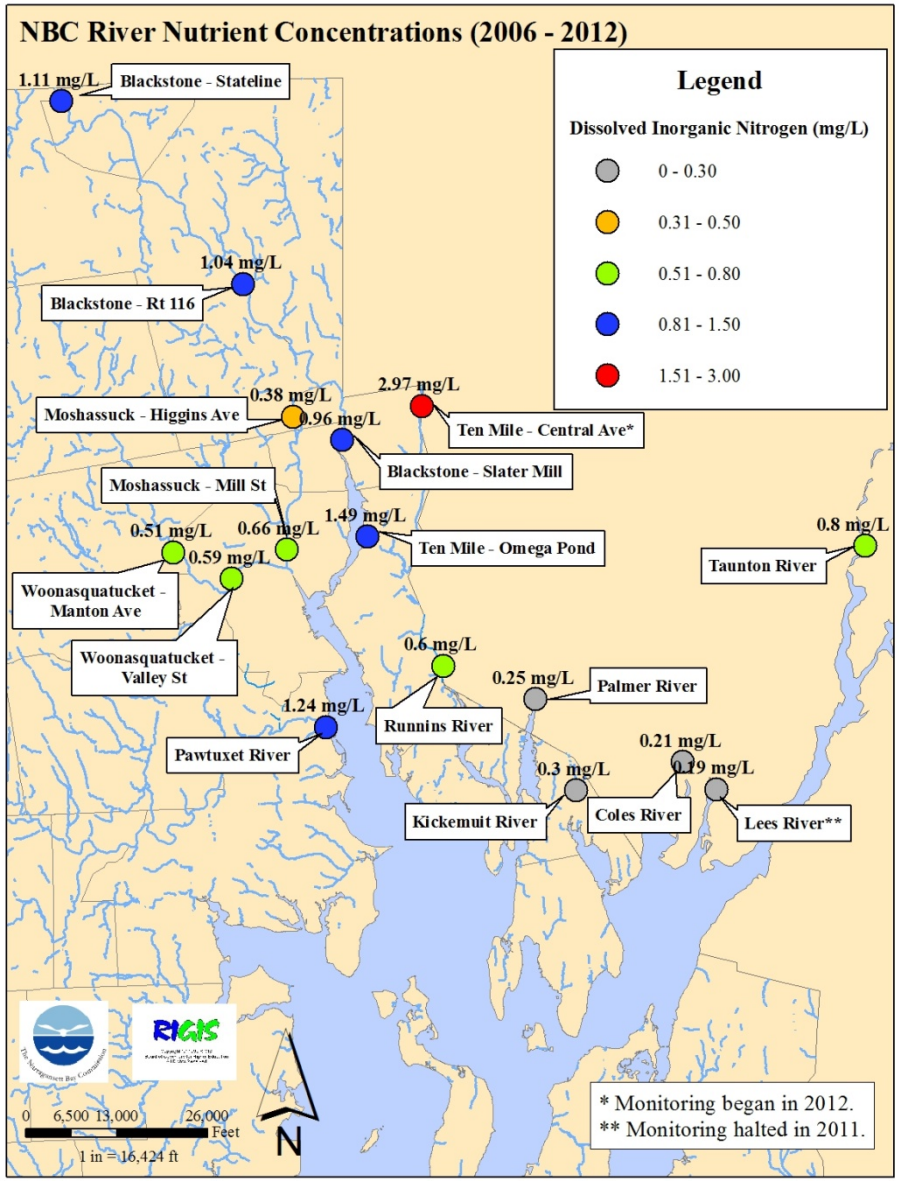


Total Dissolved Nitrogen (TDN)

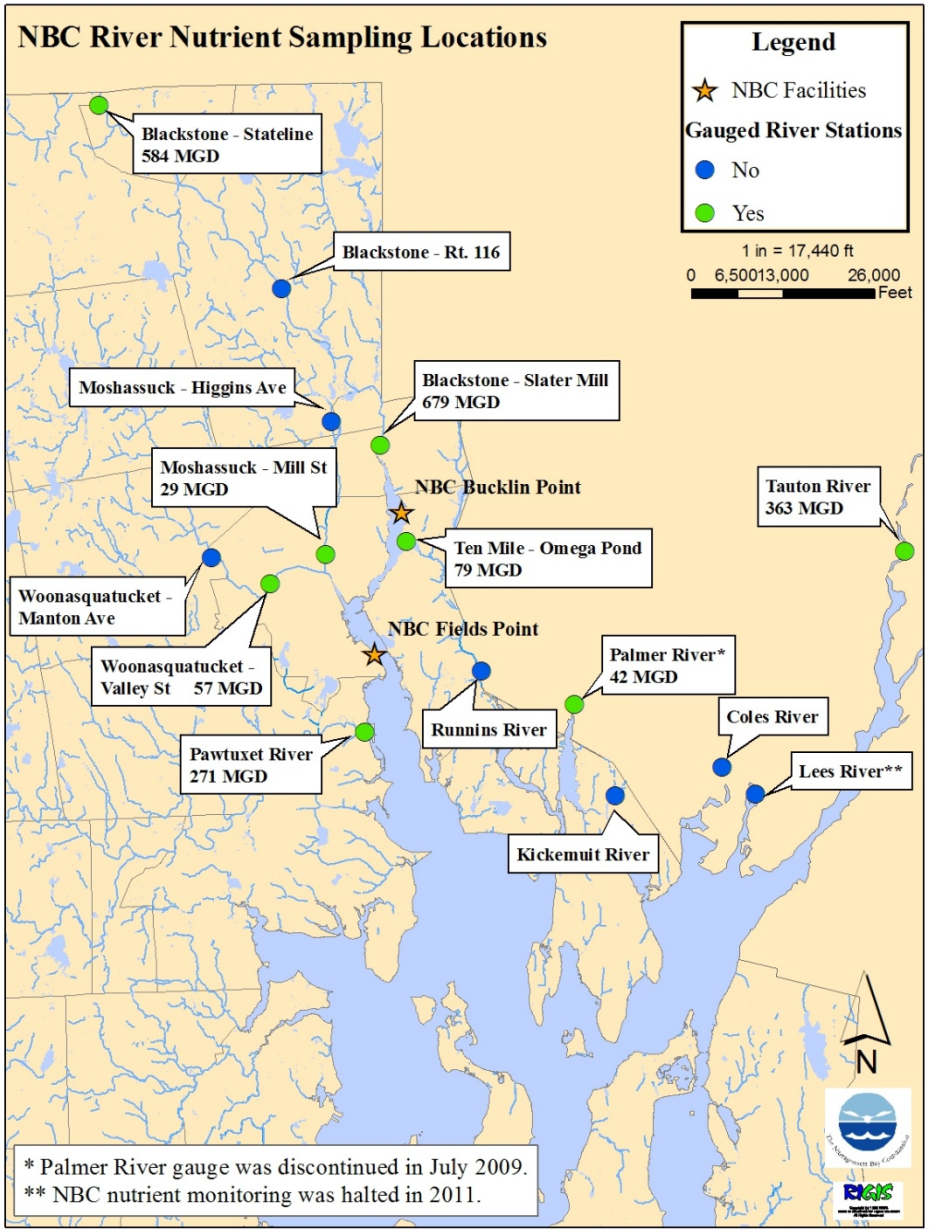


- Highest concentrations recorded on Ten Mile River; Central Ave station represents 2012 data only (3.24 – 1.85 mg/L)
- Pawtuxet River is the 2nd highest concentration (1.58 mg/L)
- Blackstone River is the 3rd highest (1.41 – 1.27 mg/L)
- Taunton River is 4th highest (1.15 mg/L)

Dissolved Inorganic Nitrogen (DIN)



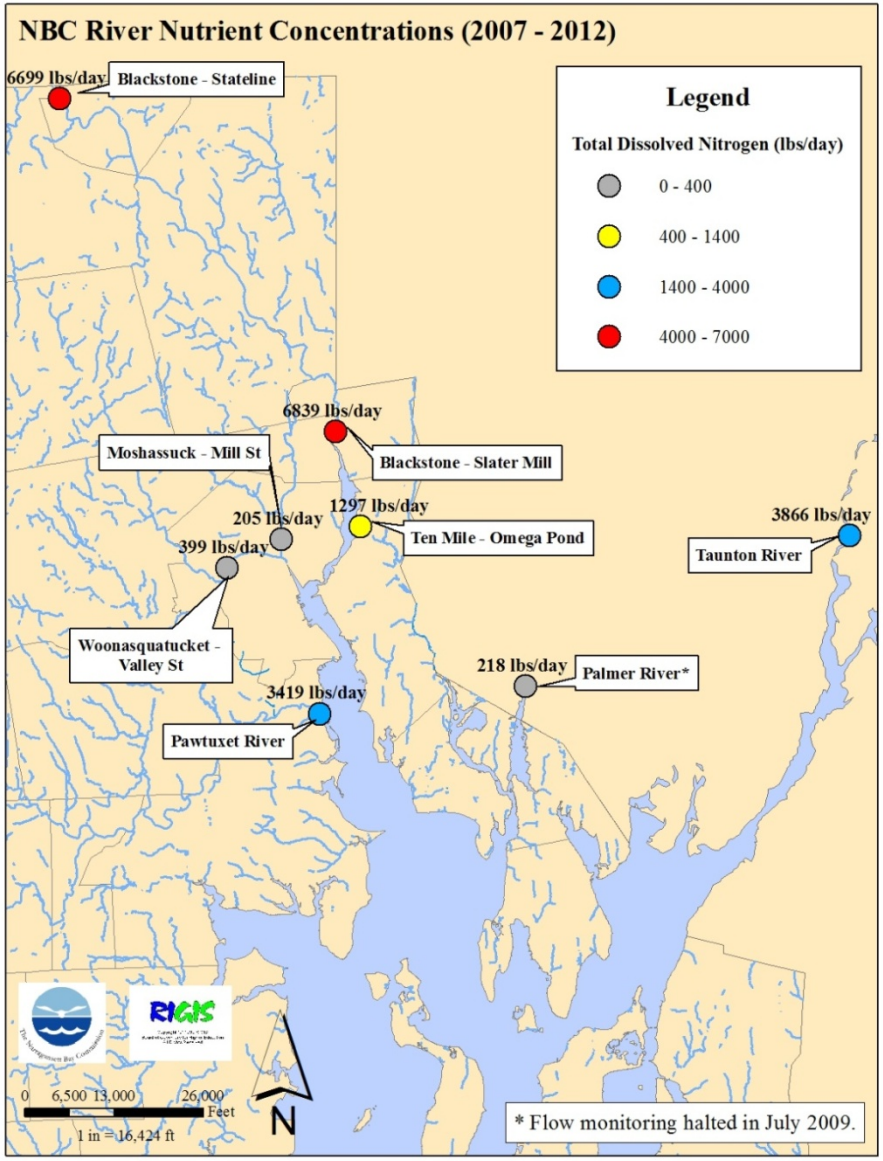
- Similar trend as TDN
- Highest concentrations recorded on Ten Mile River; Central Ave station represents 2012 data only (2.97 – 1.49 mg/L)
- Pawtuxet River is the 2nd highest concentration (1.24 mg/L)
- Blackstone River is the 3rd highest (1.11 – 0.96 mg/L)
- Remainder of rivers have concentrations below 1 mg/L DIN



Freshwater Flow into NB

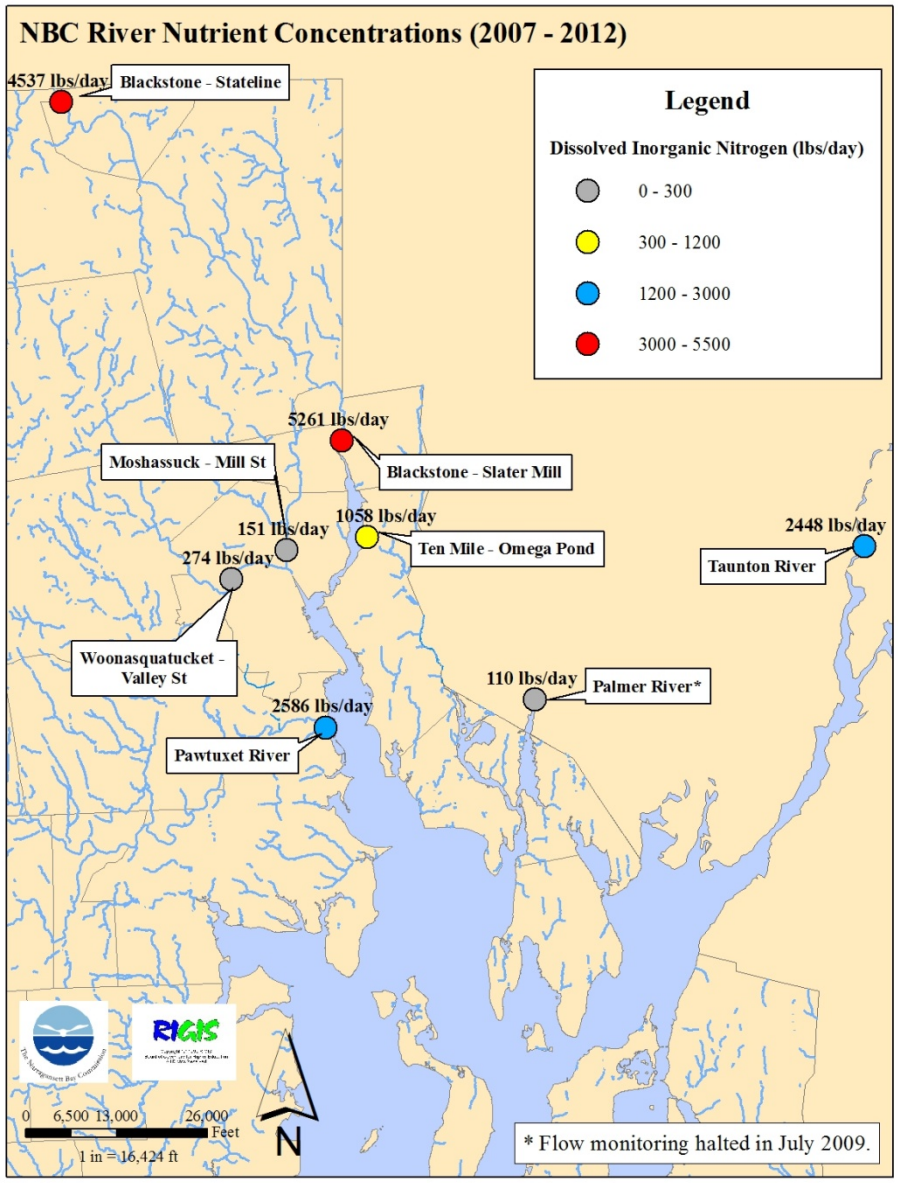
- With concentrations & flow of rivers can estimate nitrogen loading
- Only 7 NBC stations presently have flow data available
- Blackstone River has highest flow (679 MGD)
- Followed by:
  - ✓Taunton River 363 MGD
  - ✓Pawtuxet River 281 MGD

Total Dissolved Nitrogen Loading

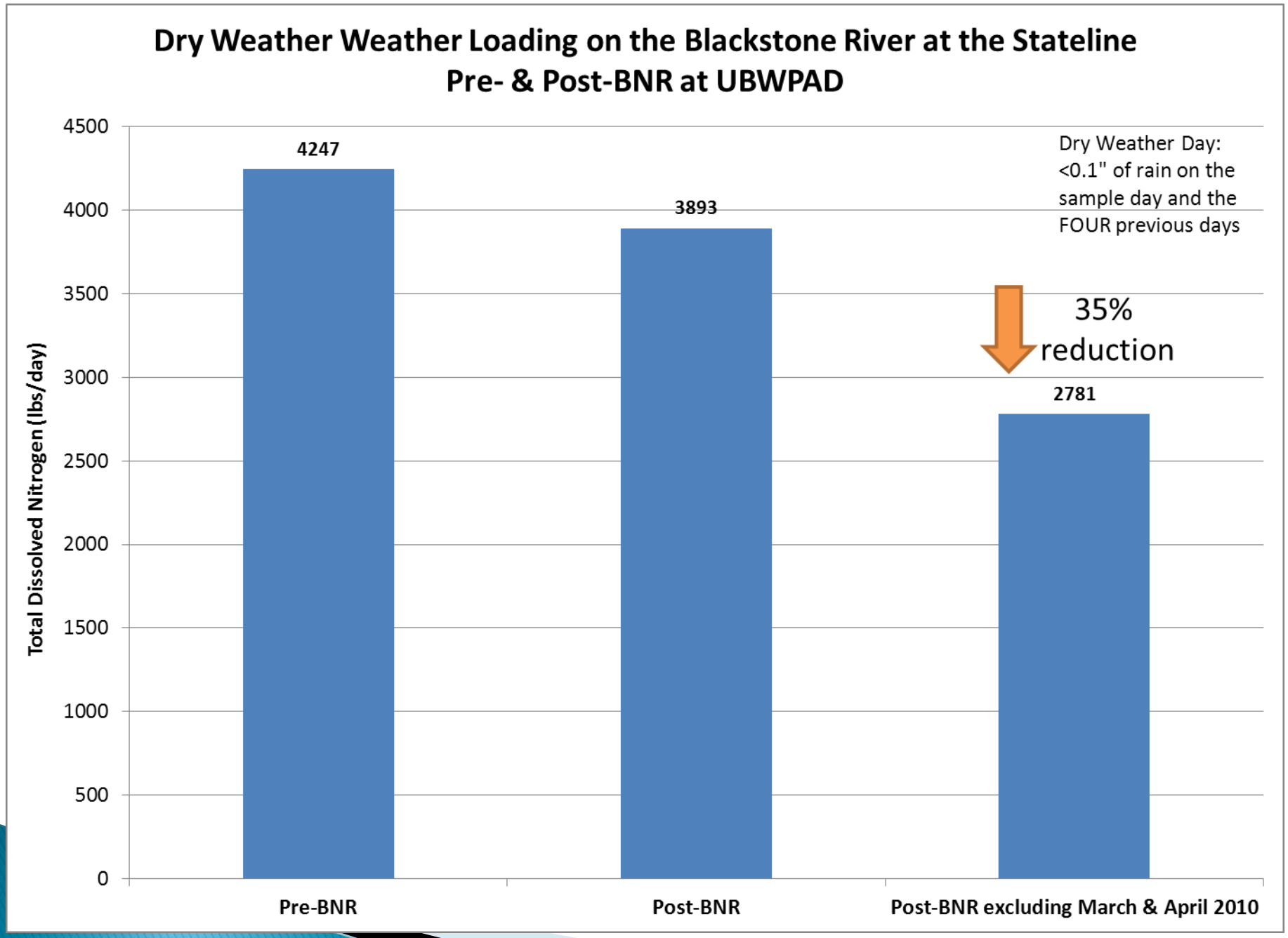


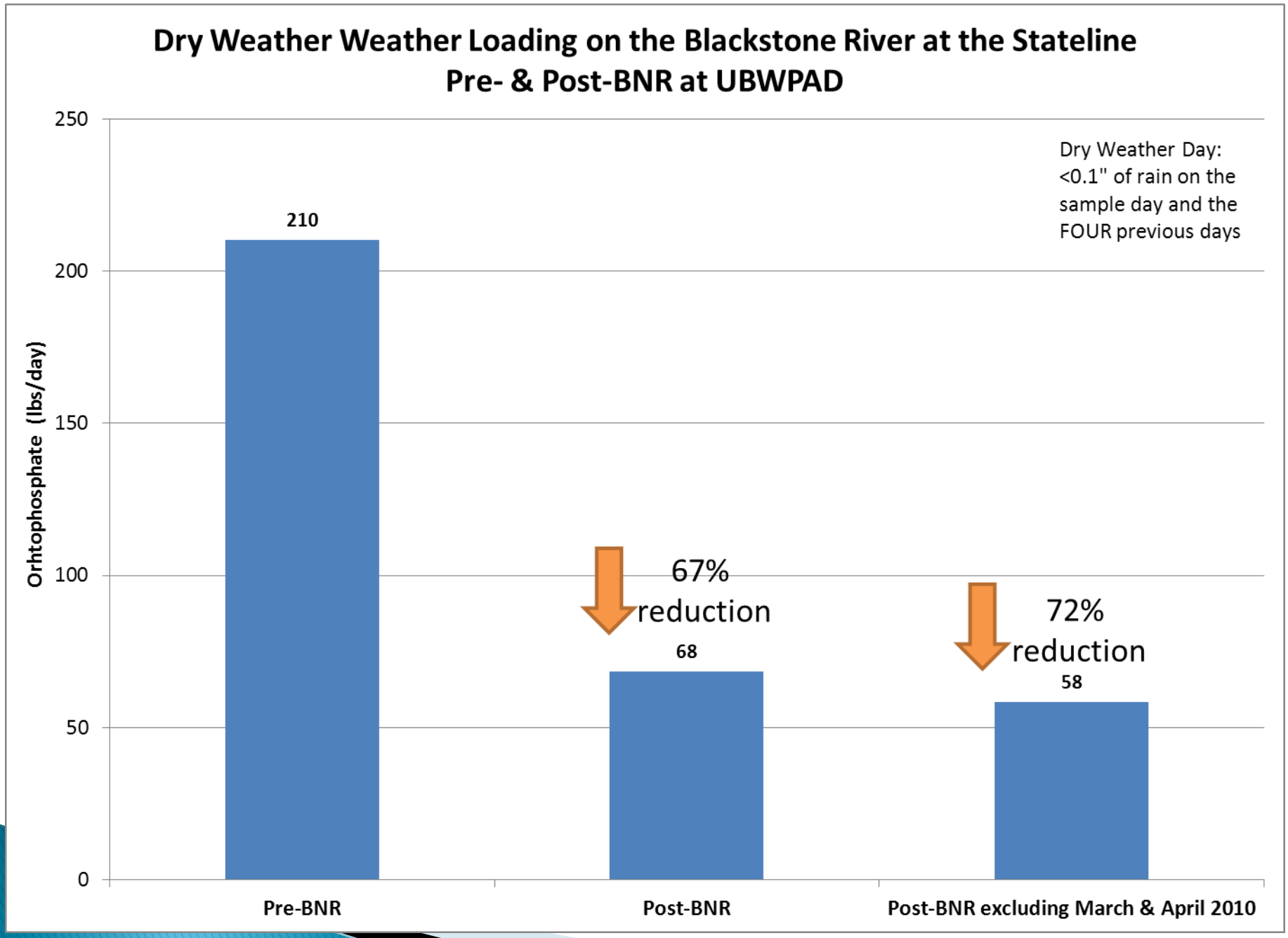
- Highest TDN loading on the Blackstone River (6699 – 6839 lbs/day)
- 2nd highest loading enters from the Taunton River (3866 lbs/day)
- Pawtuxet River is the 3rd highest loading (3419 lbs/day)
- With 79 MGD & high concentrations, Ten Mile had 4th highest loading

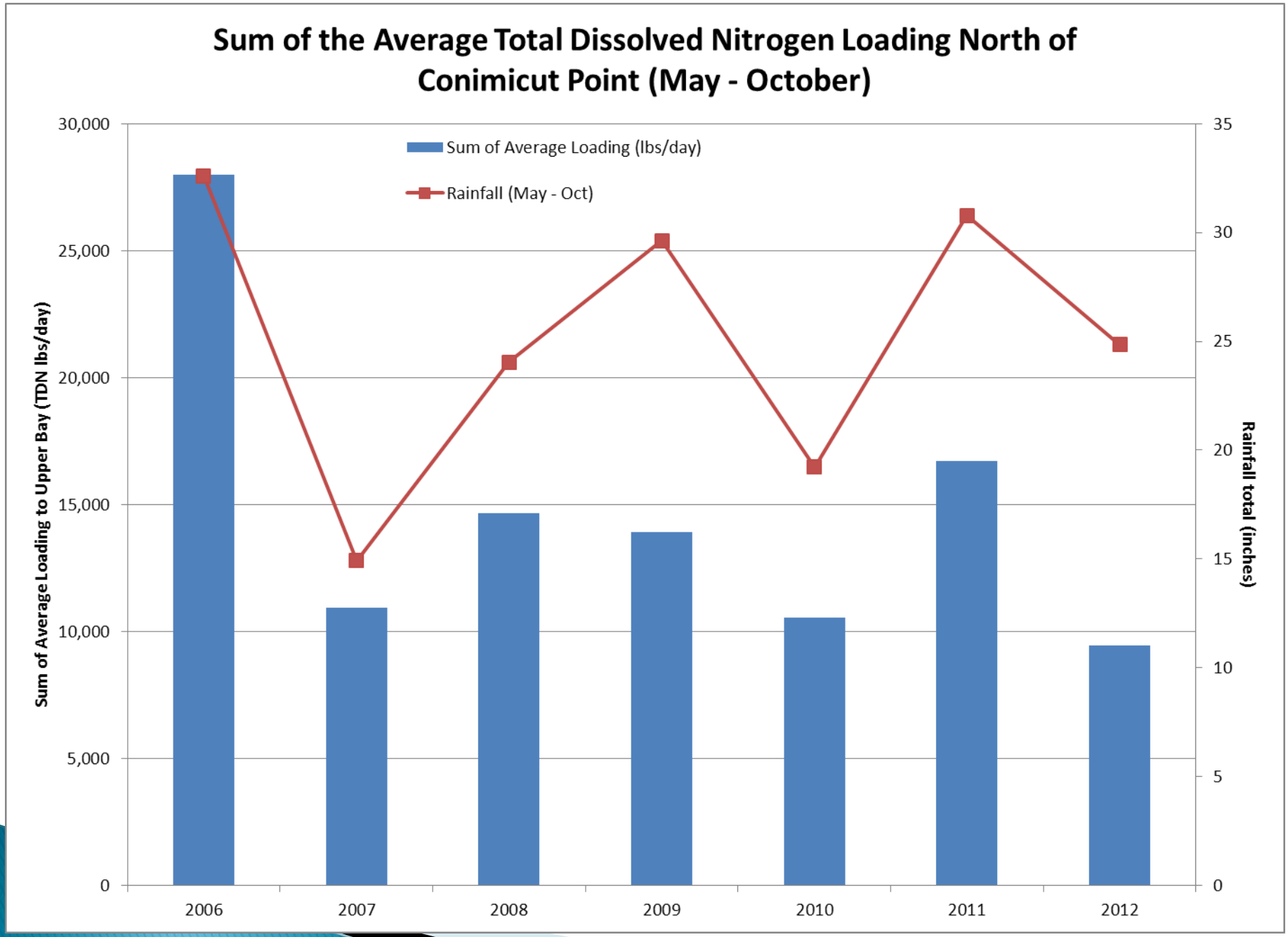
Dissolved Inorganic Nitrogen Loading



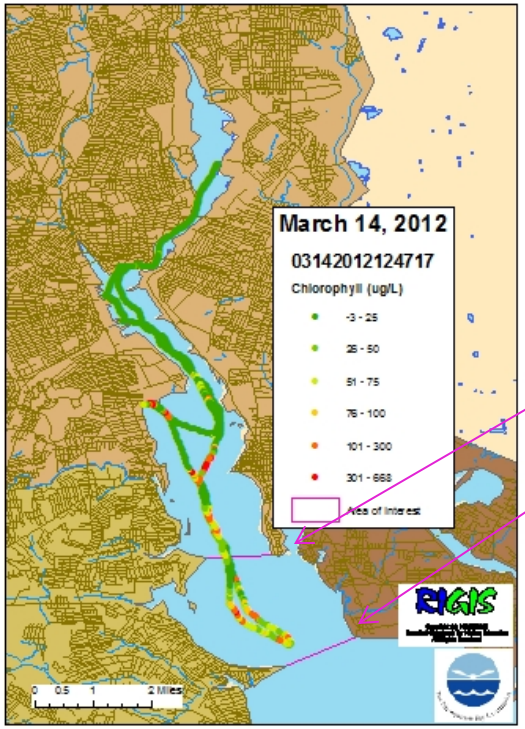
- Same trends as TDN loading
- Highest loading from the Blackstone River (5261 – 4537 lbs/day)
- Pawtuxet (2586 lbs/day) & Taunton (2448 lbs/day) Rivers have similar loading
- Again, high concentrations cause Ten Mile to have high loading (1058 lbs/day)


Dry Weather Weather Loading on the Blackstone River at the Stateline
Pre- & Post-BNR at UBWPAD
Total Dissolved Nitrogen (lbs/day)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4247
3893
2781
Dry Weather Day: <0.1" of rain on the sample day and the FOUR previous days
35% reduction
Pre-BNR
Post-BNR
Post-BNR excluding March & April 2010

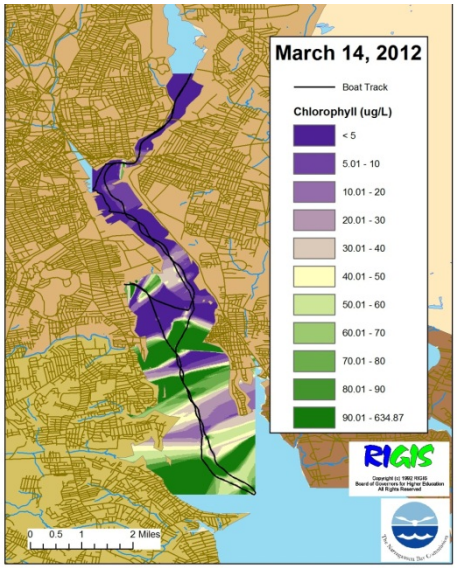

Dry Weather Weather Loading on the Blackstone River at the Stateline
Pre- & Post-BNR at UBWPAD
Dry Weather Day:
<0.1" of rain on the
sample day and the
FOUR previous days
Orhtophosphate (lbs/day)
250
200
150
100
50
0
210
67%
reduction
68
72%
reduction
58
Pre-BNR
Post-BNR
Post-BNR excluding March & April 2010

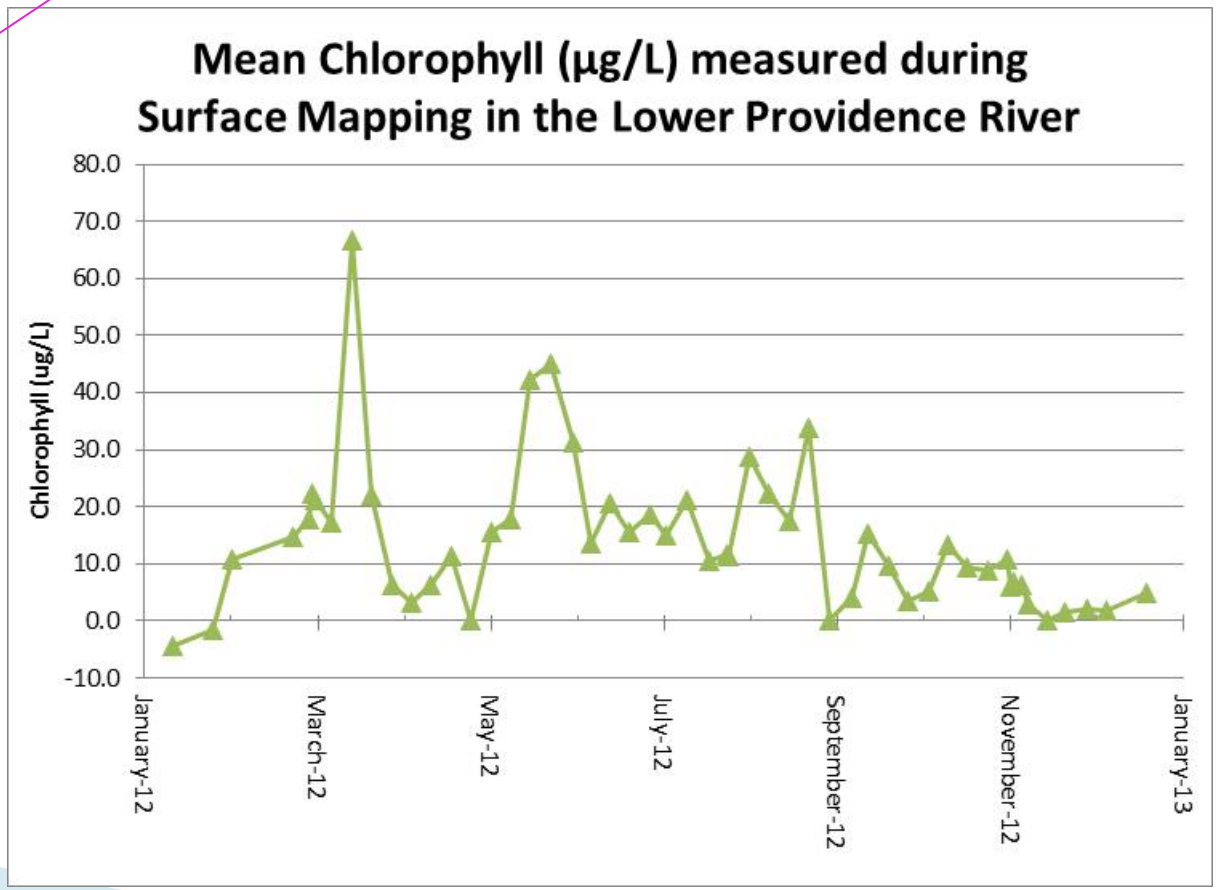

Sum of the Average Total Dissolved Nitrogen Loading North of Conimicut Point (May - October)
Sum of Average Loading (lbs/day)
Rainfall (May - Oct)
Sum of Average Loading to Upper Bay (TDN lbs/day)
Rainfall total (inches)
30,000
25,000
20,000
15,000
10,000
5,000
0
35
30
25
20
15
10
5
0
2006
2007
2008
2009
2010
2011
2012

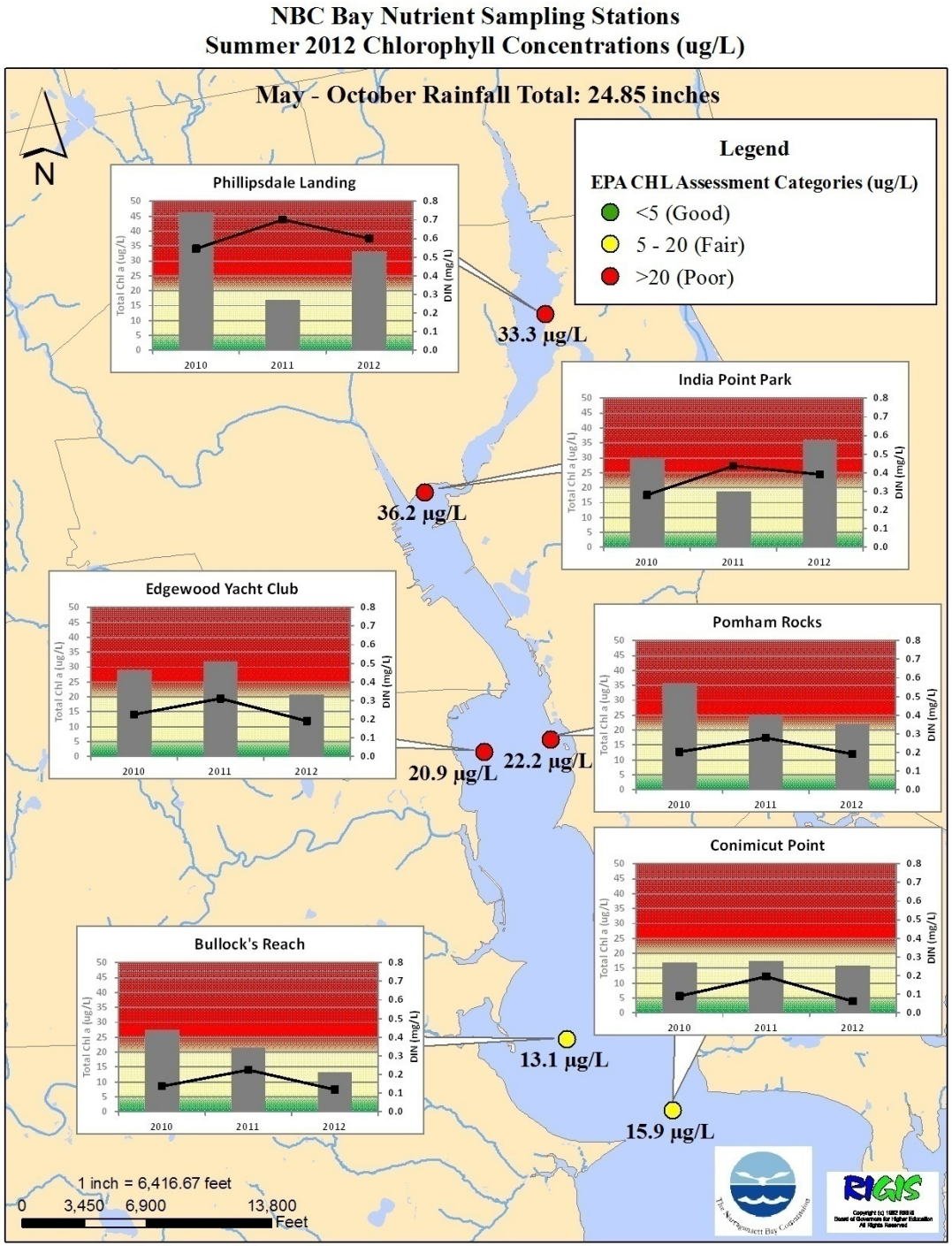
How does chlorophyll vary over the course of a year in a particular stretch of the estuary?



Here we look at the average chlorophyll measurements between the 2 pink lines on each mapping survey



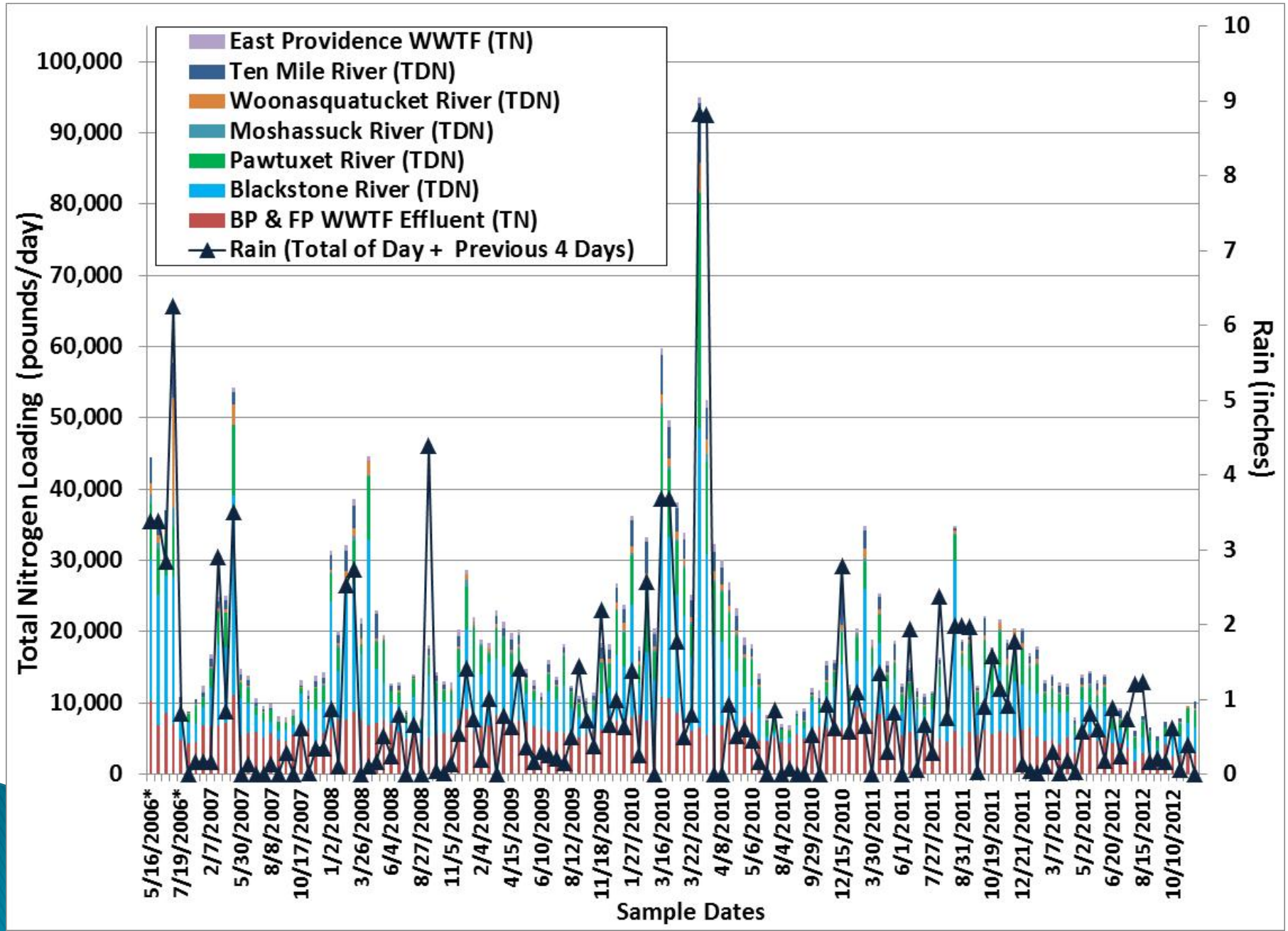




Chlorophyll

- Data starting 2010
- Varies annually (46 – 13 µg/L)
- Not all years show the expected down bay gradient (2011 EYC is highest)
- Conimicut Point is constantly 16-17 µg/L
- GSO Mid-Bay station averages 4 µg/L
- Coastal Condition report recommends <=5µg/L

Upper Bay Total Nitrogen Loading & Rainfall



United States Environmental Protection Agency
Office of Research and Development/Office of Water
Washington, DC 20460

EPA/842-R-08-002
December 2008
http://www.epa.gov/nccr

National Coastal Condition Report III

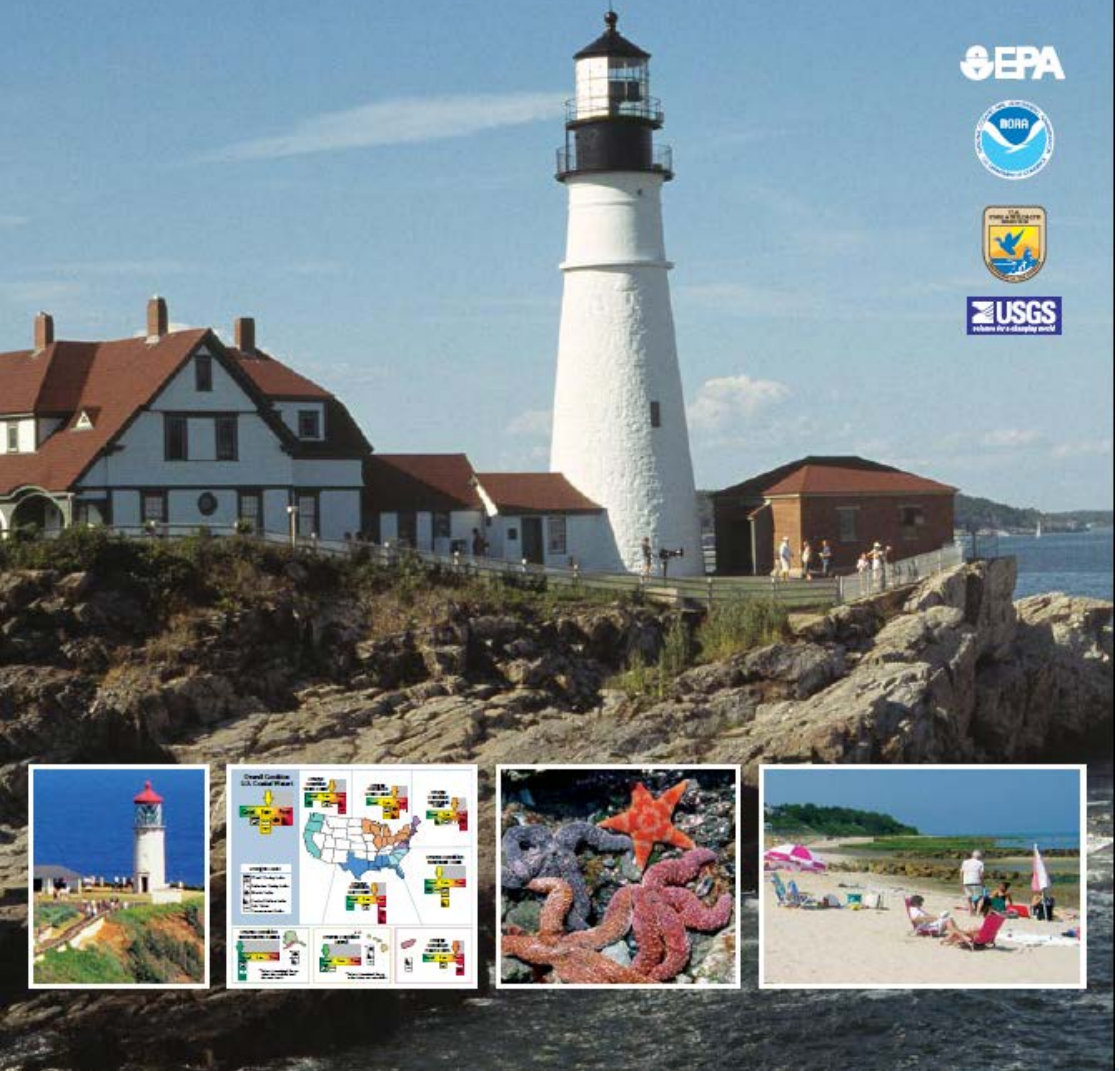


Table 1-2. Criteria for Assessing Dissolved Inorganic Nitrogen (DIN)

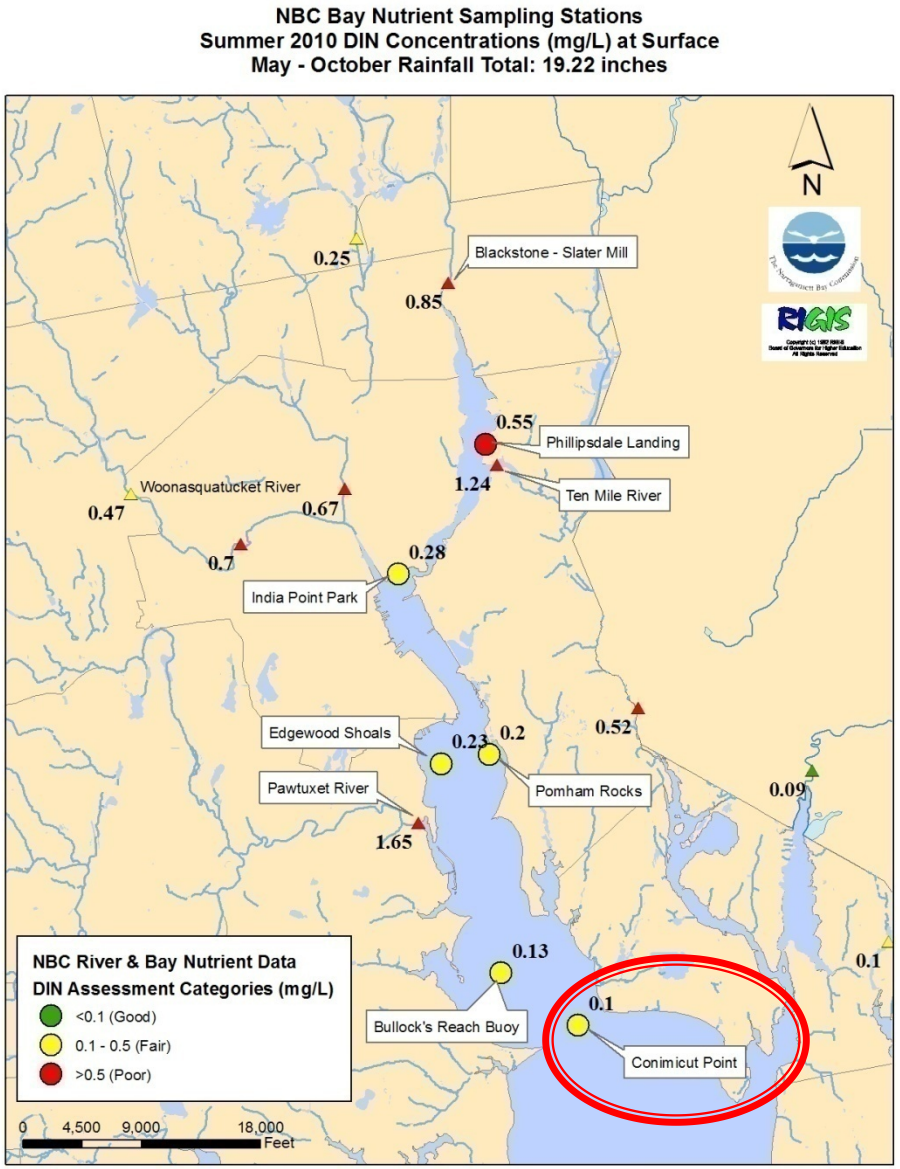
Area	Good	Fair	Poor
Northeast, Southeast, and Gulf Coast sites	< 0.1 mg/L	0.1–0.5 mg/L	> 0.5 mg/L
West Coast and Alaska sites	< 0.5 mg/L	0.5–1.0 mg/L	> 1 mg/L
Hawaii, Puerto Rico, and Florida Bay sites	< 0.05 mg/L	0.05–0.1 mg/L	> 0.1 mg/L
Regions	Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.	10% to 25% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined poor and fair condition.	More than 25% of the coastal area is in poor condition.

2010 Dissolved Inorganic Nitrogen Conc.

May – October

Rainfall Total: **19.22 inches**

Station DIN (mg/L) Good <0.1 Fair 0.1-0.5 Poor >0.5	2010 DIN (mg/L)	2010 EPA NEP criteria
Phillipsdale Landing	0.55	Poor
India Point Park	0.28	Fair
Edgewood Yacht Club	0.23	Fair
Pomham Rocks	0.20	Fair
Bullock's Reach	0.13	Fair
Conimicut Point	0.10	Fair

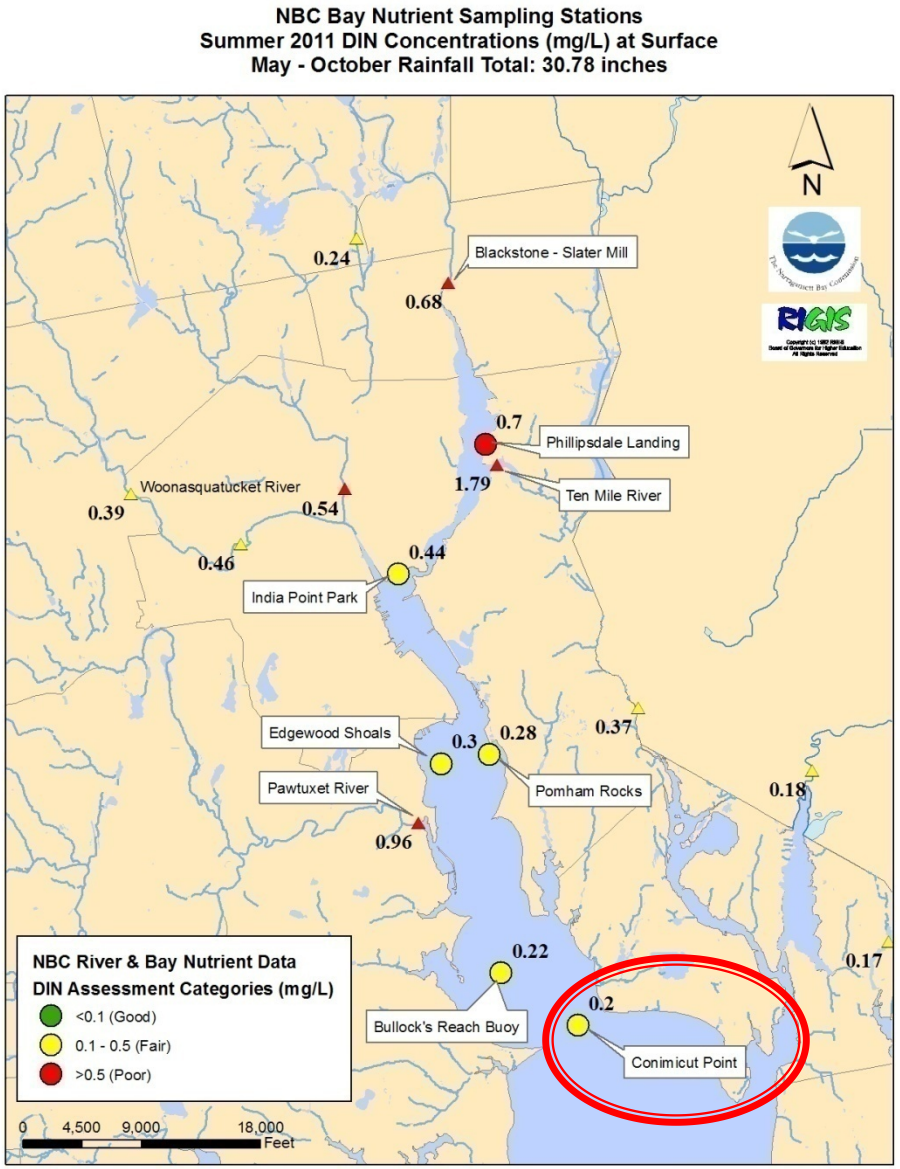


2011 Dissolved Inorganic Nitrogen Conc.

May – October

Rainfall Total: **30.78 inches**

Station DIN (mg/L) Good <0.1 Fair 0.1-0.5 Poor >0.5	2011 DIN (mg/L)	2011 EPA NEP criteria
Phillipsdale Landing	0.70	Poor
India Point Park	0.44	Fair
Edgewood Yacht Club	0.30	Fair
Pomham Rocks	0.28	Fair
Bullock's Reach	0.22	Fair
Conimicut Point	0.20	Fair

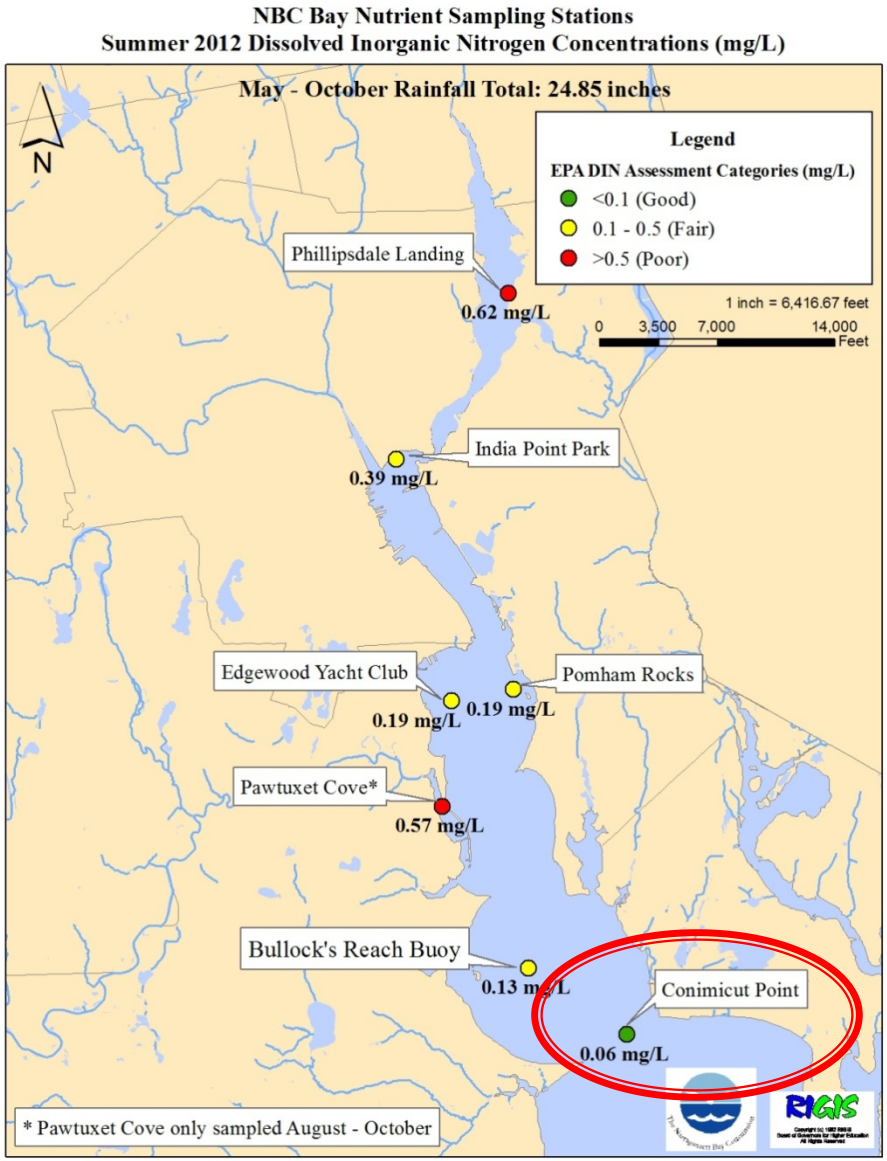


2012 Dissolved Inorganic Nitrogen Conc.

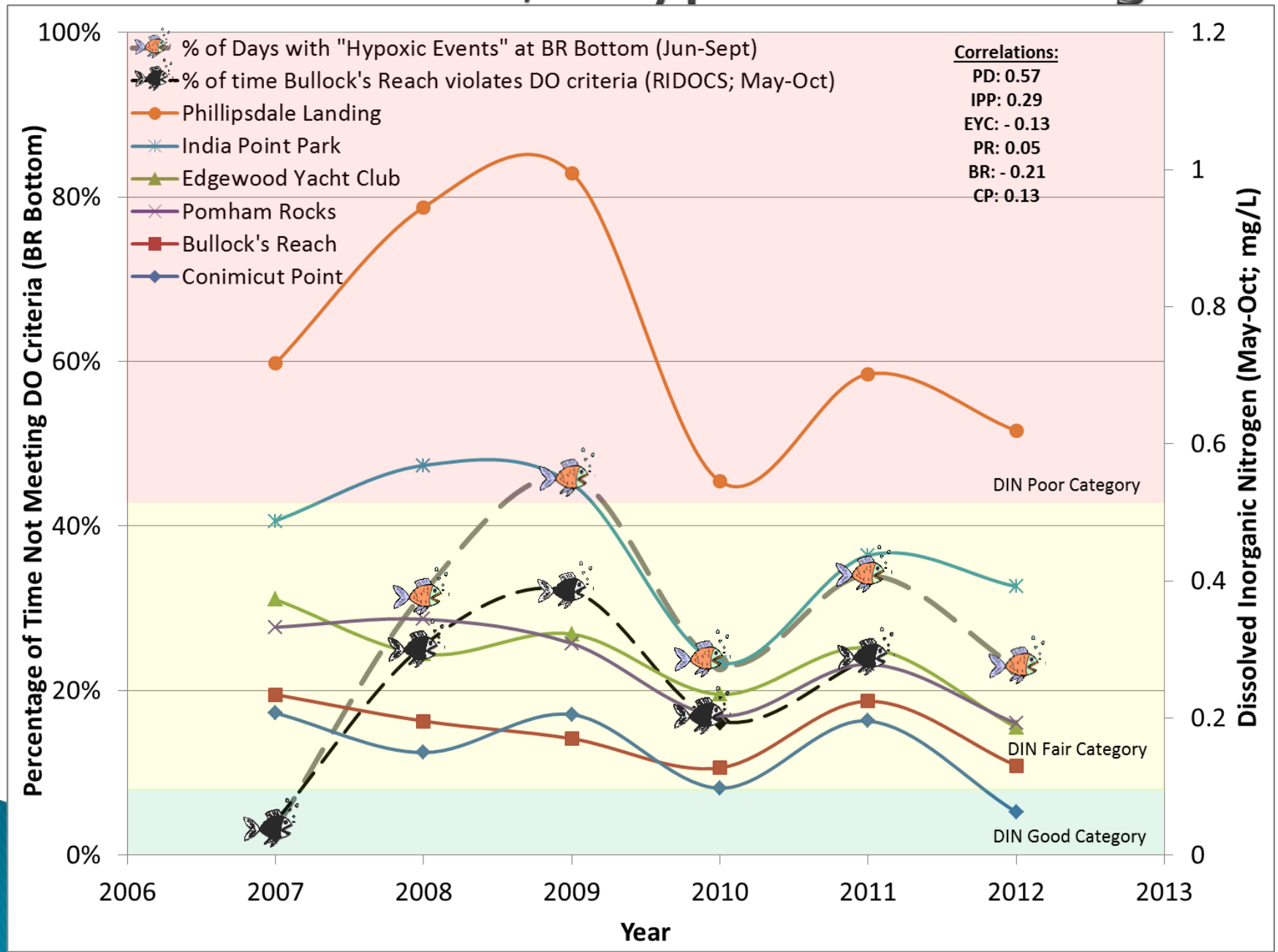
May – October

Rainfall Total: **24.85 inches**

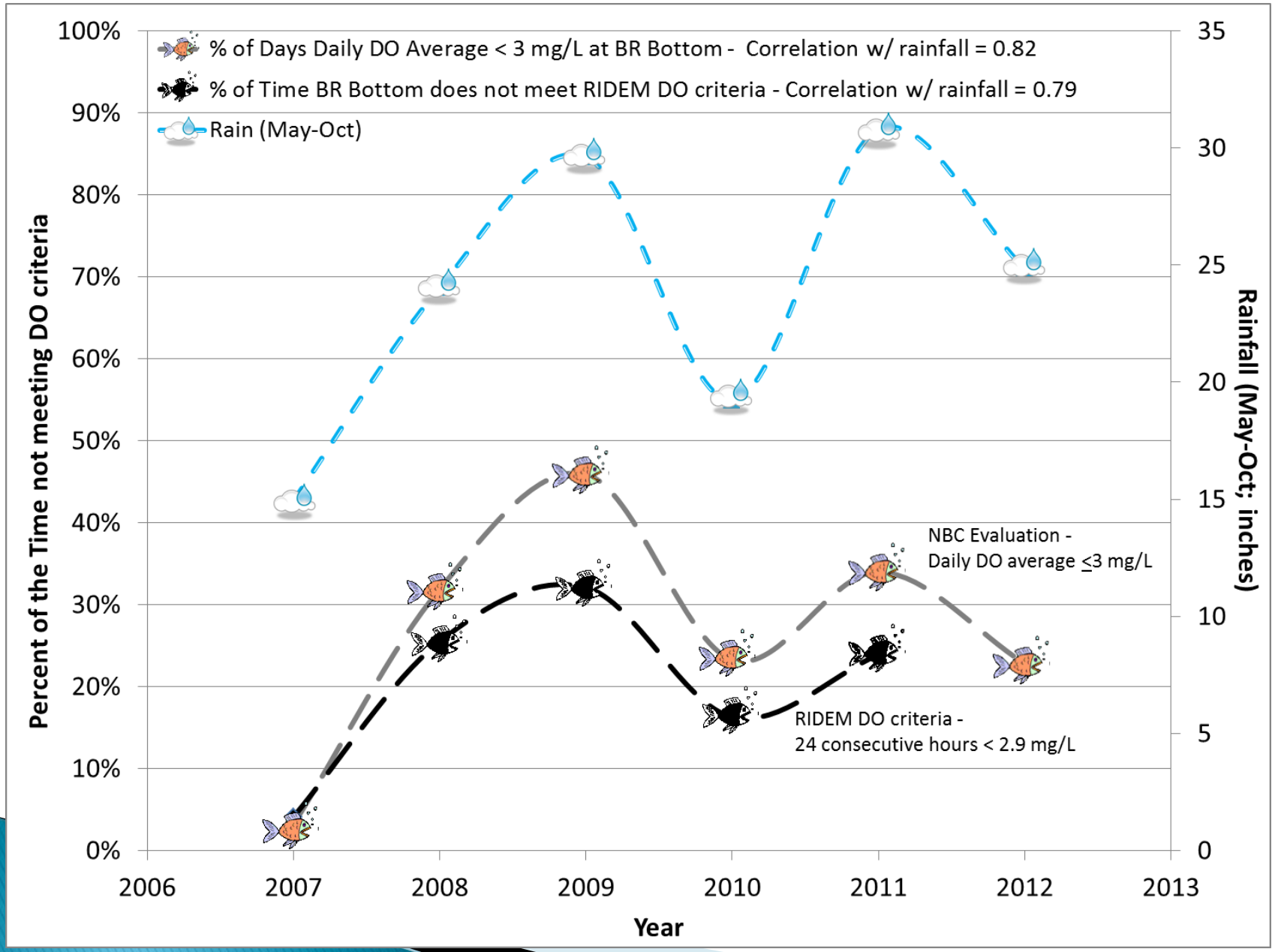
Station DIN (mg/L) Good <0.1 Fair 0.1-0.5 Poor >0.5	2012 DIN (mg/L)	2012 EPA NEP criteria
Phillipsdale Landing	0.62	Poor
India Point Park	0.39	Fair
Edgewood Yacht Club	0.19	Fair
Pomham Rocks	0.19	Fair
Bullock's Reach	0.13	Fair
Conimicut Point	0.06	Good

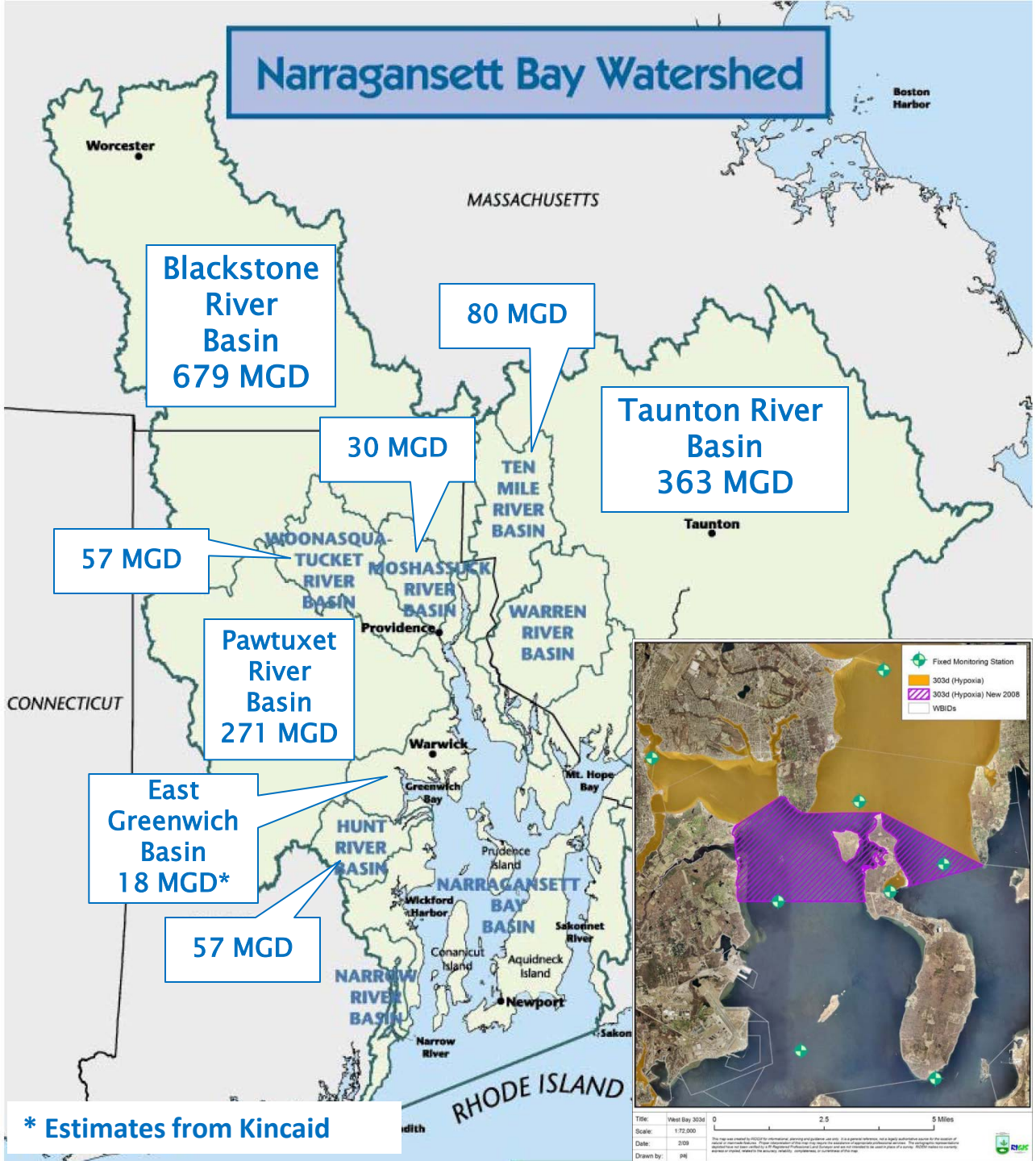


Correlation b/t Hypoxia & Nitrogen



Correlation b/t Hypoxia & Rainfall





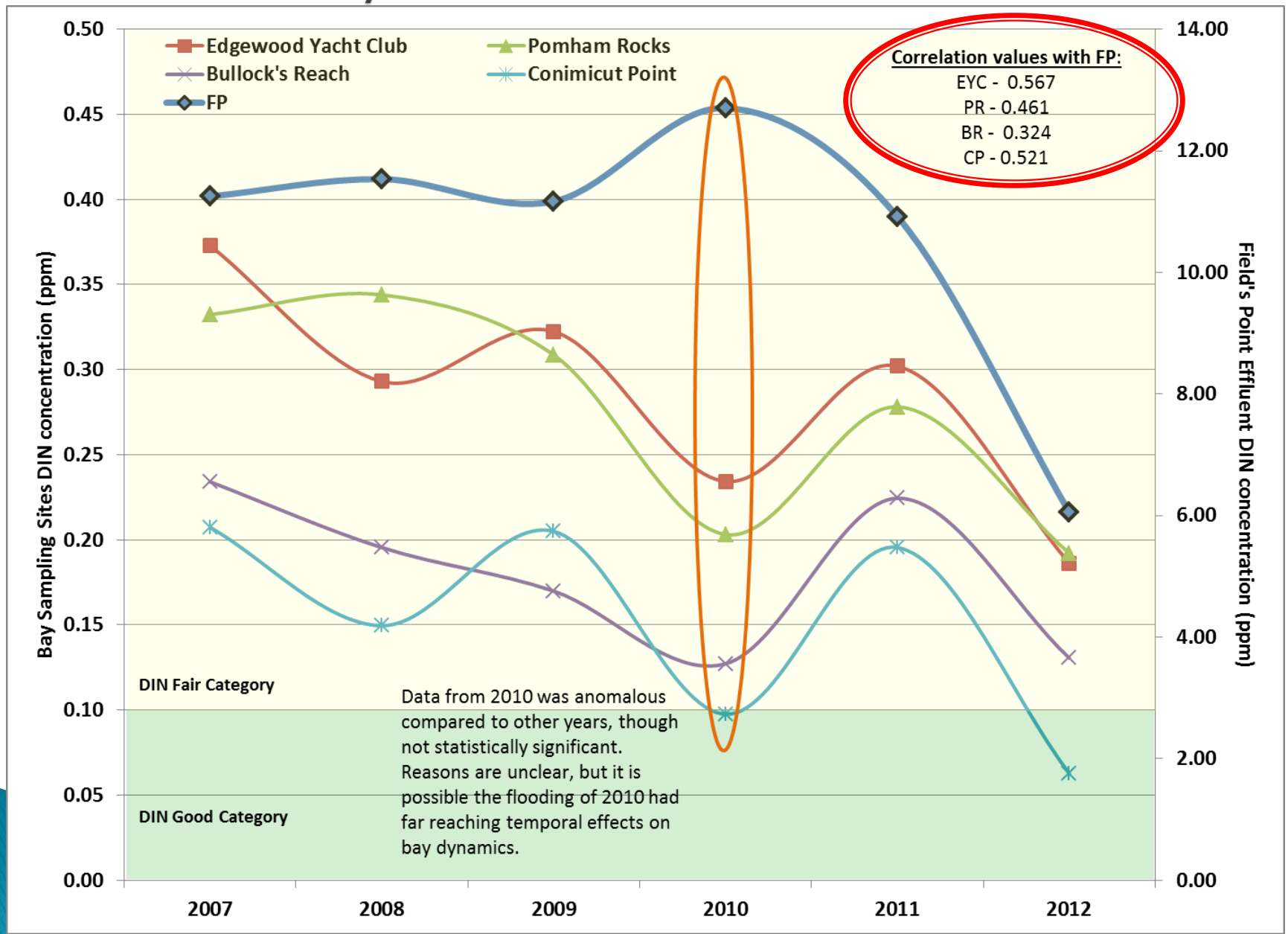
Freshwater Inputs

- Majority of NB's freshwater flow enters through the Providence River
- Approx. 1050 mi^2 Narragansett Bay watershed is gauged
- Approx. 223 mi^2 of the watershed is NOT gauged

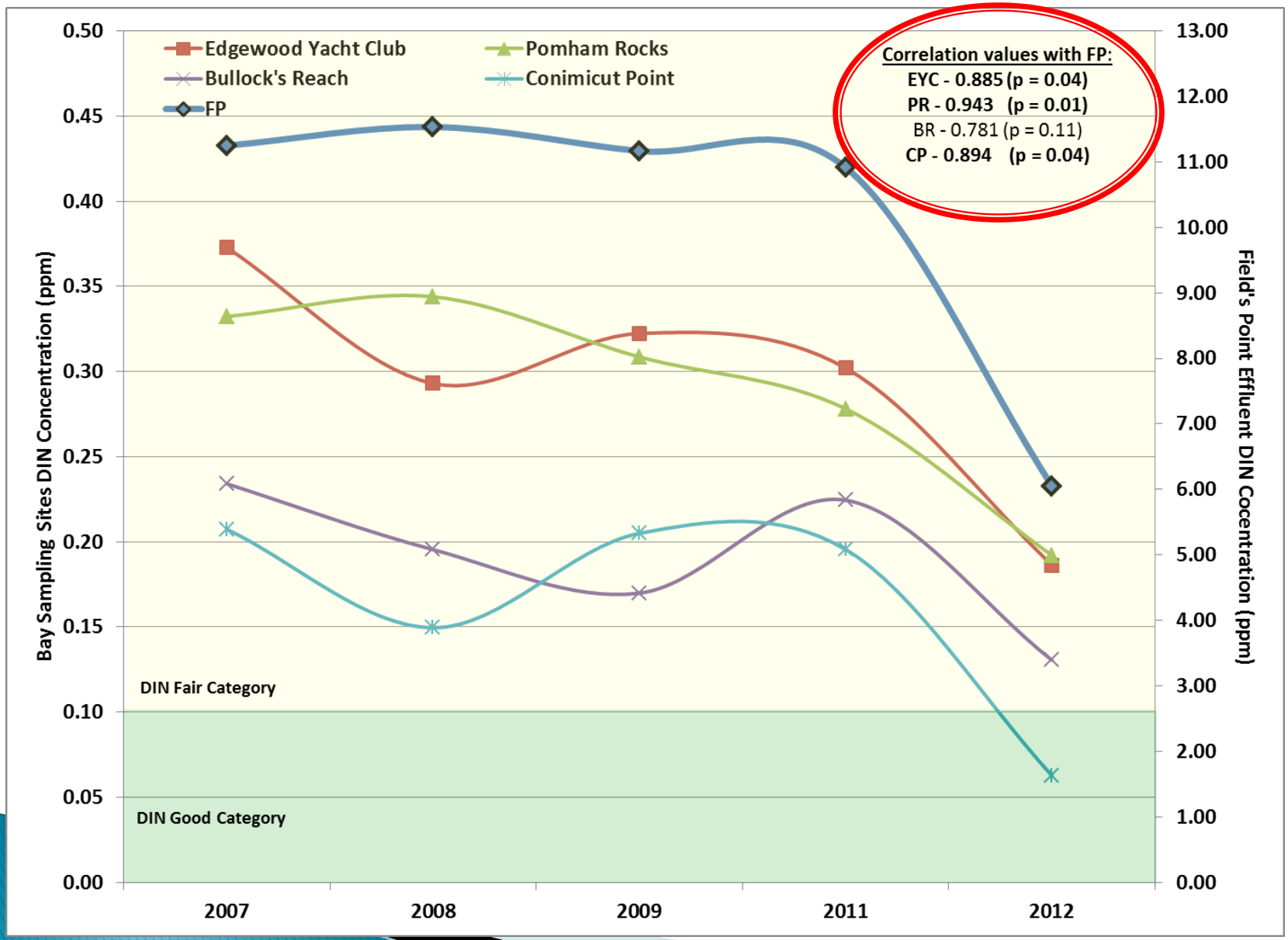
(Info from Ullman, Brush, Kincaid)

- DO Impaired waters are where fresh waters enter bay!!!

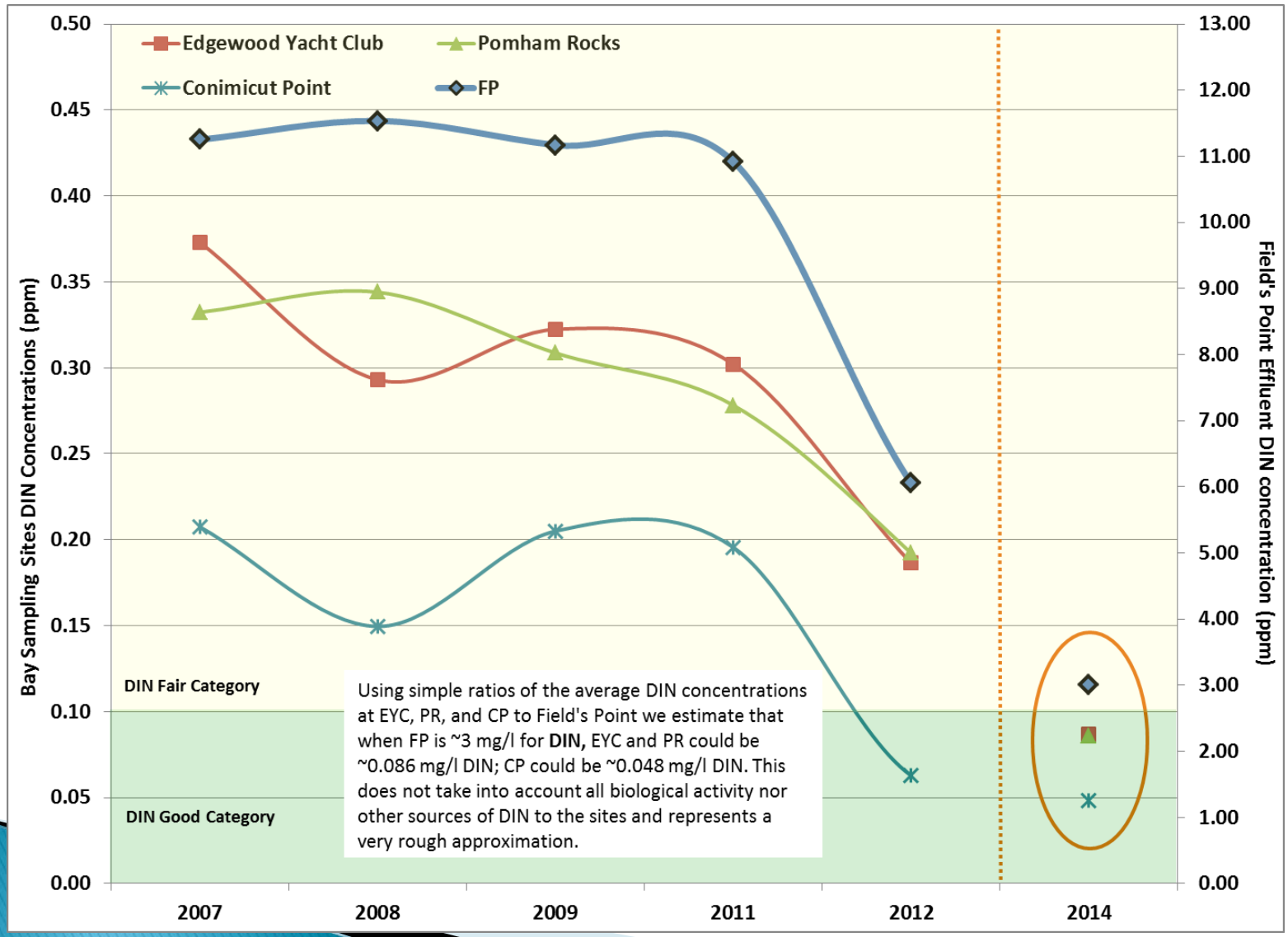
DIN Concentrations at Field's Point and sampling sites south of FP May – October 2007 – 2012



DIN Concentrations at Field's Point and sampling sites south of FP May – October 2007 – 2012 (no 2010 data)



FUTURE PREDICATIONS of DIN Concentrations at Field's Point and sampling sites south of FP May – October 2007 – 2012 (no 2010 data)– FP @ 5ppm TN



Questions ???