

# Narragansett Bay Commission

## *Overview of NBC Construction Activities, Monitoring Initiatives & Findings*

Thomas Uva

Director of Planning, Policy & Regulation

Narragansett Bay Commission



# Narragansett Bay Commission Facilities

- Narragansett Bay Commission (NBC) is a quasi-state agency
- Service Area
  - ✓ Serve 360,000 people in urban metropolitan area of Rhode Island
  - ✓ ~7,500 commercial and industrial customers
- Own/Operate the two largest WWTFs in Rhode Island
  - ✓ Field's Point – Providence River
  - ✓ Bucklin Point – Seekonk River
- Facilities located at the headwaters of Narragansett Bay





# *NBC Bacteria Reduction Projects*

# CSOs – What's the Problem?

## CSO outfall discharges:

- Contain everything that is typically flushed or poured down the drain
- Contain residential, industrial & commercial business discharges, diluted with Stormwater
- Contain Stormwater and runoff pollutants, like oils, grease, heavy metals, nutrients, road salt, sand, animal waste, litter, plastics...
- 772 US Cities have CSOs



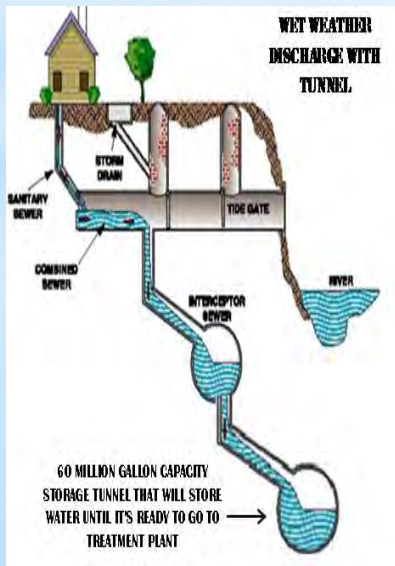
# CSOs – What's the Problem?

## CSO outfall discharges:

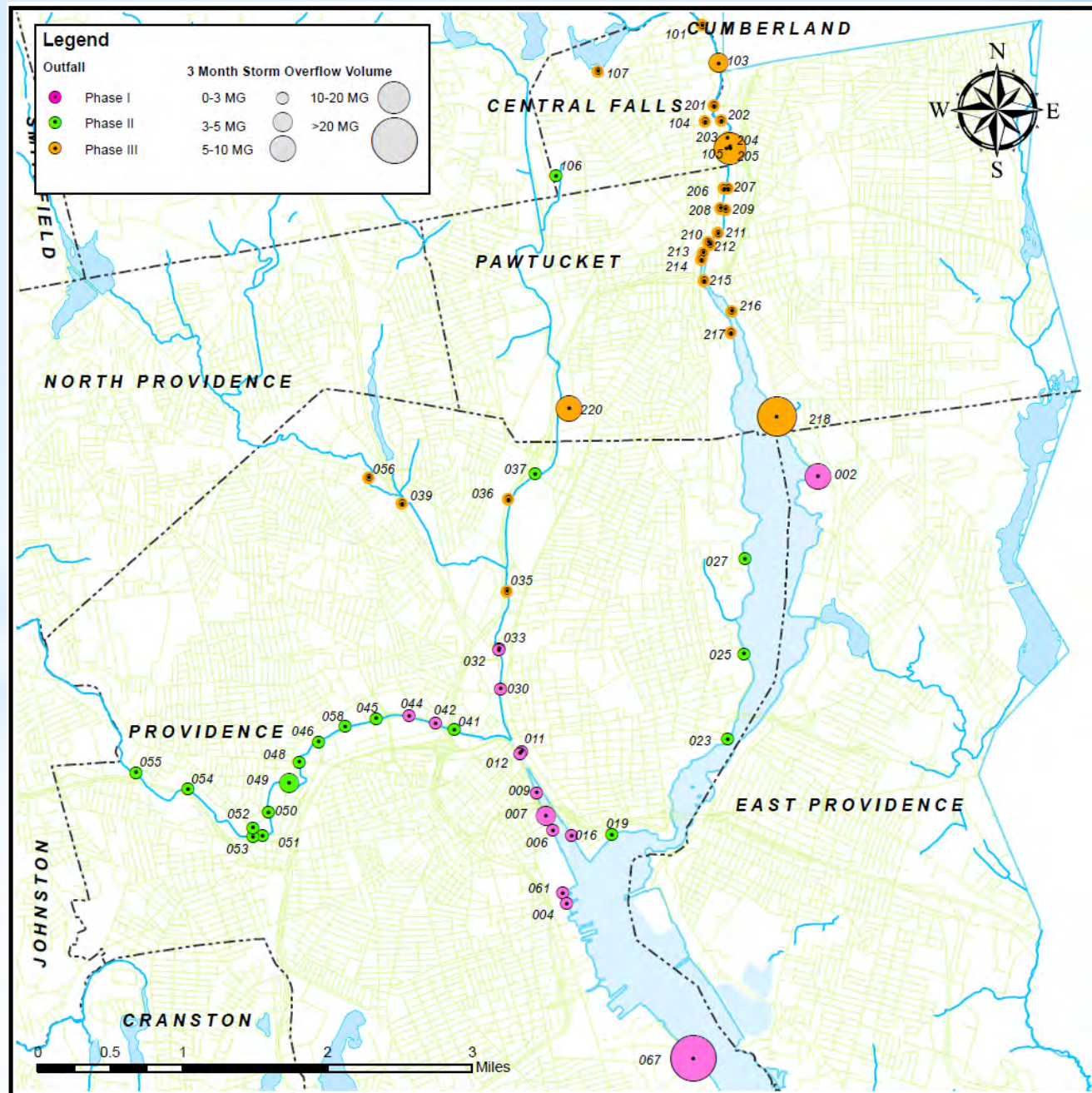
- Cause Aesthetic impacts - Floatables
- Cause beach closures due to bacterial contamination
- Cause shellfishing bed closures
- Adversely impact human and aquatic health,
- Cause violations of water quality standards – Bacteria, DO, Clarity
- Can promote Algae growth and reduce oxygen levels in the water.



# Combined Sewer Overflow Volumes



*Combined system with the 65 million gallon CSO Tunnel, which captures & stores stormwater until it can be treated at the WWTF.*



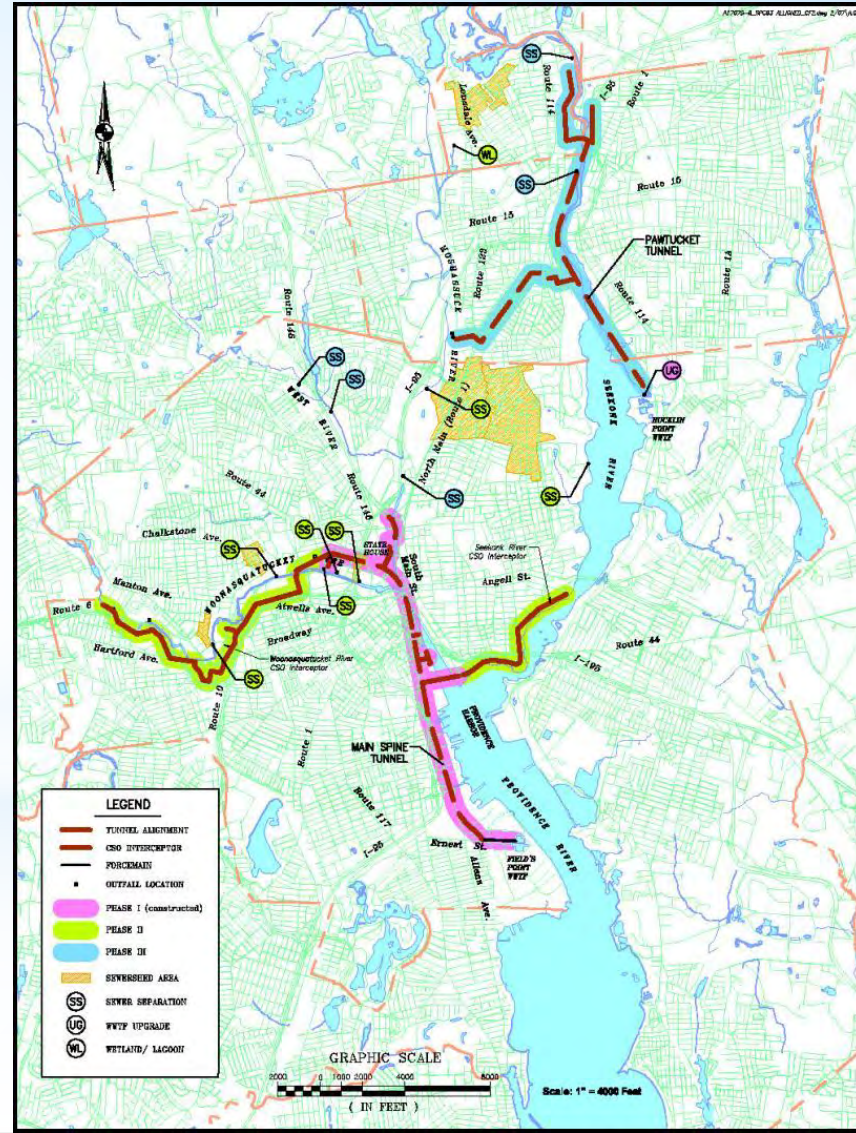
# CSO Abatement Project: 3 Phases - ~\$1.4 Billion

## Three Phases over 20 years

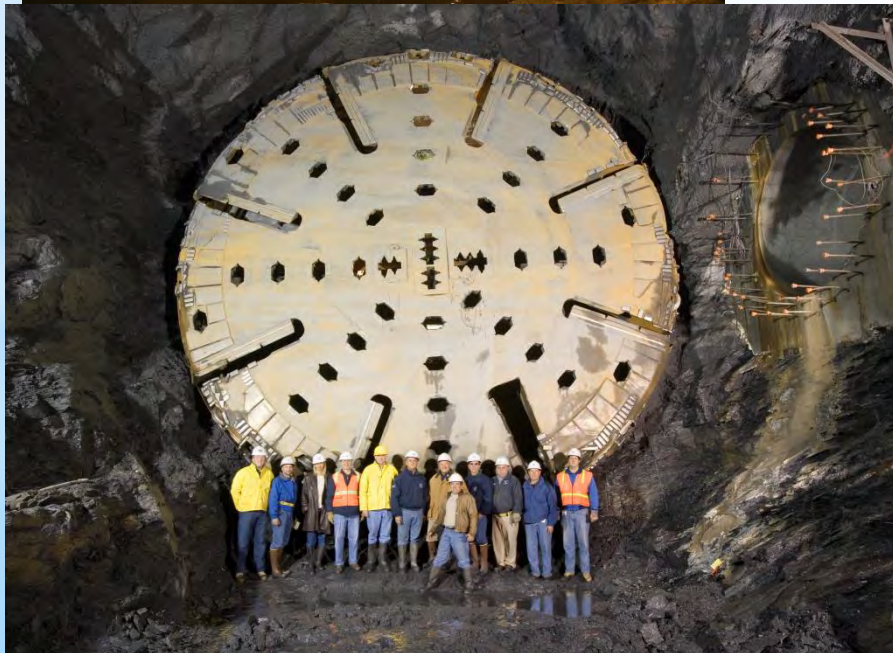
- Design storm: 3-month -1.6 inches of rain in 6 hours

### PHASE I (2001 – Nov 2008)

- 26 ft diameter deep rock tunnel
- 3+ mile long, 300 ft. below ground
- 62 MG design capacity (actual~65 MG)
- 7 drop shafts to divert flow to tunnel
- Diversion structures at 8 CSOs
- Relief structures at 2 interceptors
- Collects sewer/stormwater from 12 CSOs in FP area
- **Actual Cost: ~\$359 million**



# CSO Abatement Tunnel: Phase I



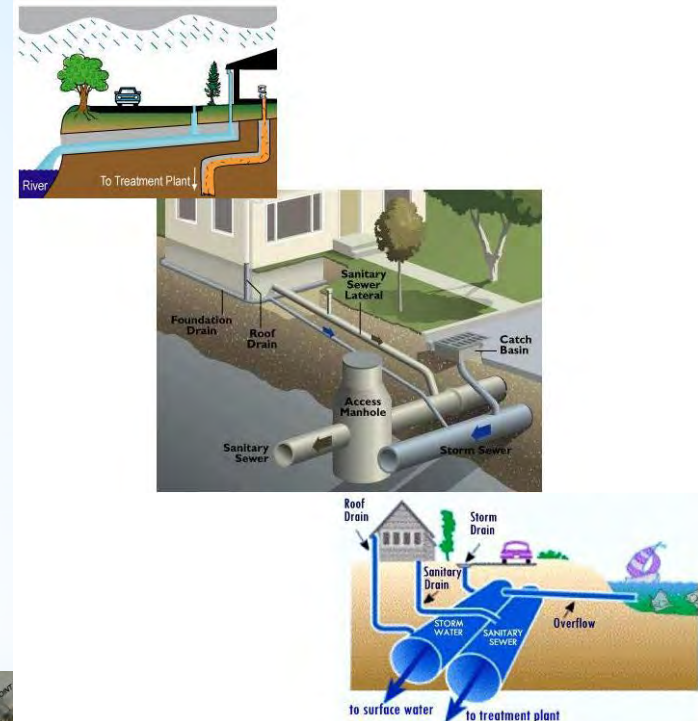
## Expected benefits:

- Reduce annual CSO volume by 39%
- Reduce fecal coliform bacteria load by 40%
- Reduce TSS by 30%
- Reduce BOD by 31%
- Reduce the acre-days of shellfish closure in northern half of Upper Narragansett Bay by 47% and 77% in southern half



# Phase II of CSO Abatement

- Woonasquatucket & Seekonk interceptors constructed to transport flow to the CSO tunnel
- Will Improve WQ of Urban Rivers
- Two sewer separations –
  - ✓ Construct new storm sewers via conventional open-cut trenching methods
  - ✓ Extensive utility impacts
    - ✓ \$3.6 million for gas main replacement
    - ✓ \$4.25 million for water main replacement
- Constructed wetlands facility
  - ✓ 0.32 MG of storage
  - ✓ Pumped to sanitary sewer after rain event
  - ✓ Overflows to wetlands when tanks are full
- Flows to interceptors end of 2014
- Whole project completed 2015
- Project costs: ~\$213 million



# Phase III of CSO Abatement

- 1998 Conceptual Design Report Amendment included:
  - ✓ Pawtucket Tunnel-13,000 feet long, 26 feet diameter
  - ✓ 3 Near surface interceptors in Central Falls & Pawtucket
  - ✓ Sewer separation at 4 CSOs
- 2014 review of 1998 plan, affordability & water quality conditions
- 1998 plan was best approach, but needed to lengthen the schedule to be financially sustainable
  - ✓ 2016-2023: CSO Tunnel, drop shafts & pump station, GI study
  - ✓ 2024-2028: Pawtucket & Central Falls interceptors, GI creation
  - ✓ 2029-2033: CSO Adit/CSO Storage Tank, GI installation
  - ✓ 2034-2038: Interceptor for 2 CSOs, GI construction & sewer sep.
- Estimated cost: **\$815 million**
- Final report submitted to RIDEM on June 2015





# *NBC Nitrogen Reduction Projects*

# Field's Point

## Biological Nutrient Removal



- Integrated Fixed Film Activated Sludge (IFAS) – Largest in the world achieving such a low effluent limit!
- Construction completed in 2013 – 5 mg/L permit limit in effect May 2014
- 2014 May – Oct = 3.4 mg/L
  - ✓ 2015 May – Oct = 4.18 mg/L
- Reduced 4,502 lbs TN/day vs. 2003

**Nitrogen Upgrade Cost**  
**~\$31 million**

# Bucklin Point

## Biological Nutrient Removal



- Upgrade to meet seasonal 8.5 mg/L TN in 2005/2006 - \$8.3M (out of total \$59M plant upgrades)
- Upgrade to meet 5 mg/L TN complete in 2014, permit in effect on July 15<sup>th</sup>, 2014
- 2014 May – Oct = 4.0 mg/L
  - ✓ 2015 May – Oct = 4.26 mg/L
- Reduced 2,341 lbs TN/day vs. 2003

**Nitrogen Upgrade Cost  
~\$13 Million**

# NBC Nitrogen Loading to Upper Bay (May – Oct) updated

	Concentration (mg/L)	Loading (lbs/day)	Percent Reduction from 2003 Loading
<b>Field's Point TN Loading</b>			
Year of Fish Kill (2003)	15.7	5,834	
May-Oct Average (2014-15)	3.8	1,193	80%
IFAS Upgrade 5 mg/L	5.0	1,540	74%
If plant achieves 3 mg/L	3.0	924	84%
<b>Bucklin Point TN Loading</b>			
Year of Fish Kill (2003)	14.8	2,908	
May-Oct Average (2014-15)	4.1	577	80%
Upgrade 5 mg/L	5.0	689	76%
If plant achieves 3 mg/L	3.0	413	86%
<b>Combined NBC Facilities</b>			
Year of Fish Kill (2003)	FP=15.7 BP=14.8	8,742	
May-Oct Average (2014-15)	FP=3.8 BP=4.1	1,770	80%
FP & BP Upgrade to 5 mg/L	FP & BP=5.0	2,229	75%
FP & BP Upgrade to 3 mg/L	FP & BP=3.0	1,337	85%

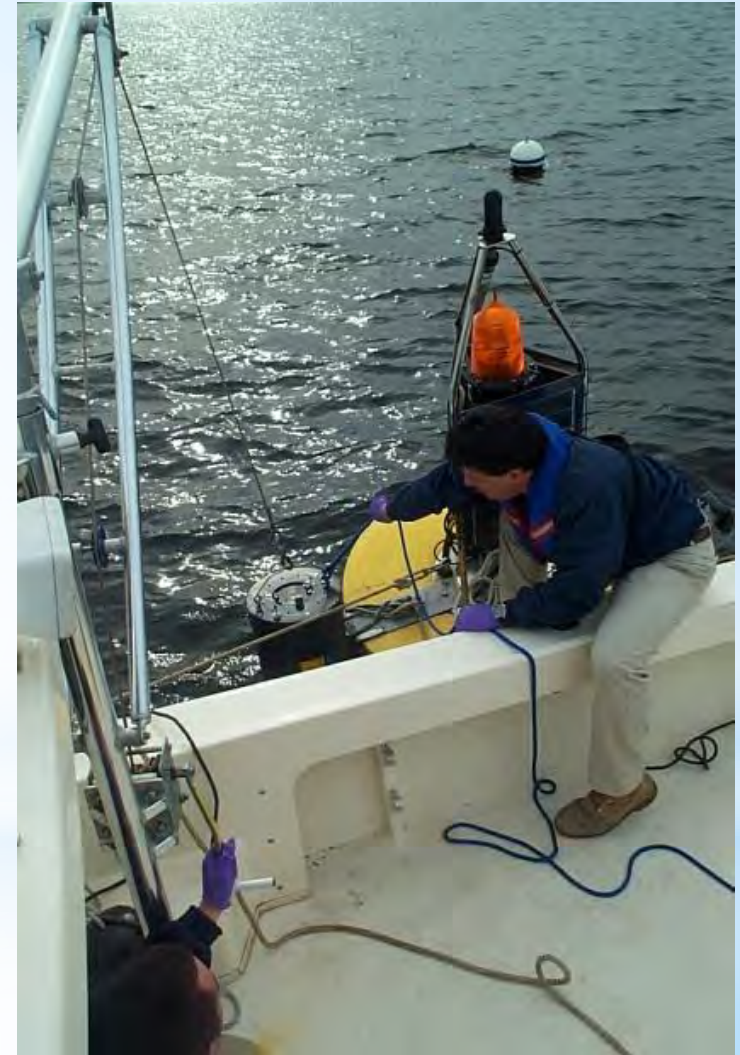
Upgrade to 3ppm TN will reduce ~433 Pounds of Nitrogen per Day - Costs >\$100M



# *NBC Water Quality Monitoring Initiatives & Studies*

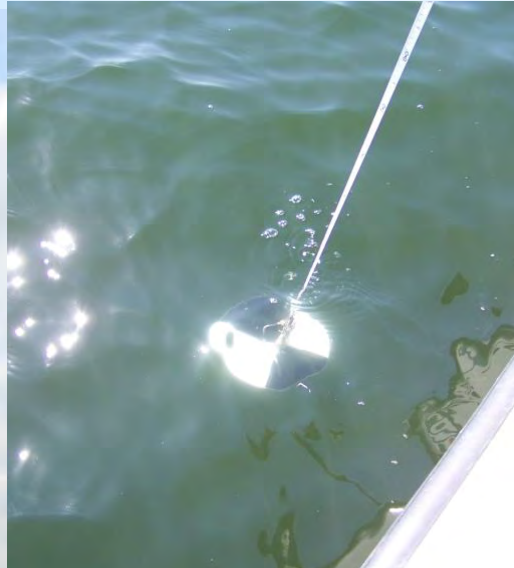
# NBC Monitoring Initiatives

- Receiving Water Monitoring provides Data & Sound Science needed to
  - ✓ Measure the success of NBC Construction Projects
  - ✓ Address Unfunded Regulatory Mandates
- NBC Operates 2 Fixed Site Monitoring Stations
  - ✓ Bullocks Reach Buoy
  - ✓ Phillipsdale Landing Site
  - ✓ On-line Monitoring of Important WQ Parameters
- Rivers flowing into Bay are monitored at the State Border for Nutrients & Bacteria
- Monitor Upper Bay and Tributary Rivers for Nutrients, Bacteria and other Pollutants





# NBC Monitoring Initiatives



## ➤ Routinely Perform:

- ✓ Seabird Water Quality Profiles
- ✓ Water Clarity Monitoring
- ✓ Real-Time Mapping of Surface Water Quality
- ✓ Benthos Monitoring
- ✓ Plankton Monitoring



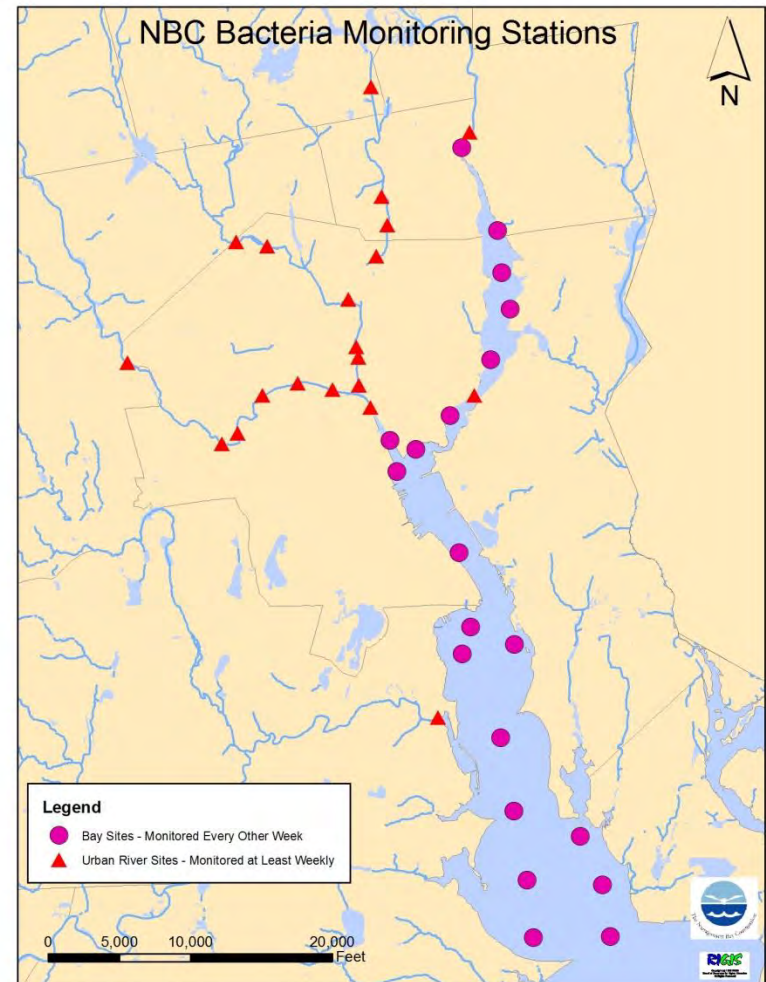
# River & Bay Bacteria Monitoring

## NBC River Monitoring Program

- NBC monitors rivers for fecal coliform & enterococci bacteria
- Monitor Up & Downstream of CSOs twice per week
- 1 station on Pawtuxet River as baseline for non-CSO river
- Data used to quickly identify CSO discharges and demonstrates effectiveness of CSO 9 Minimum Controls Program

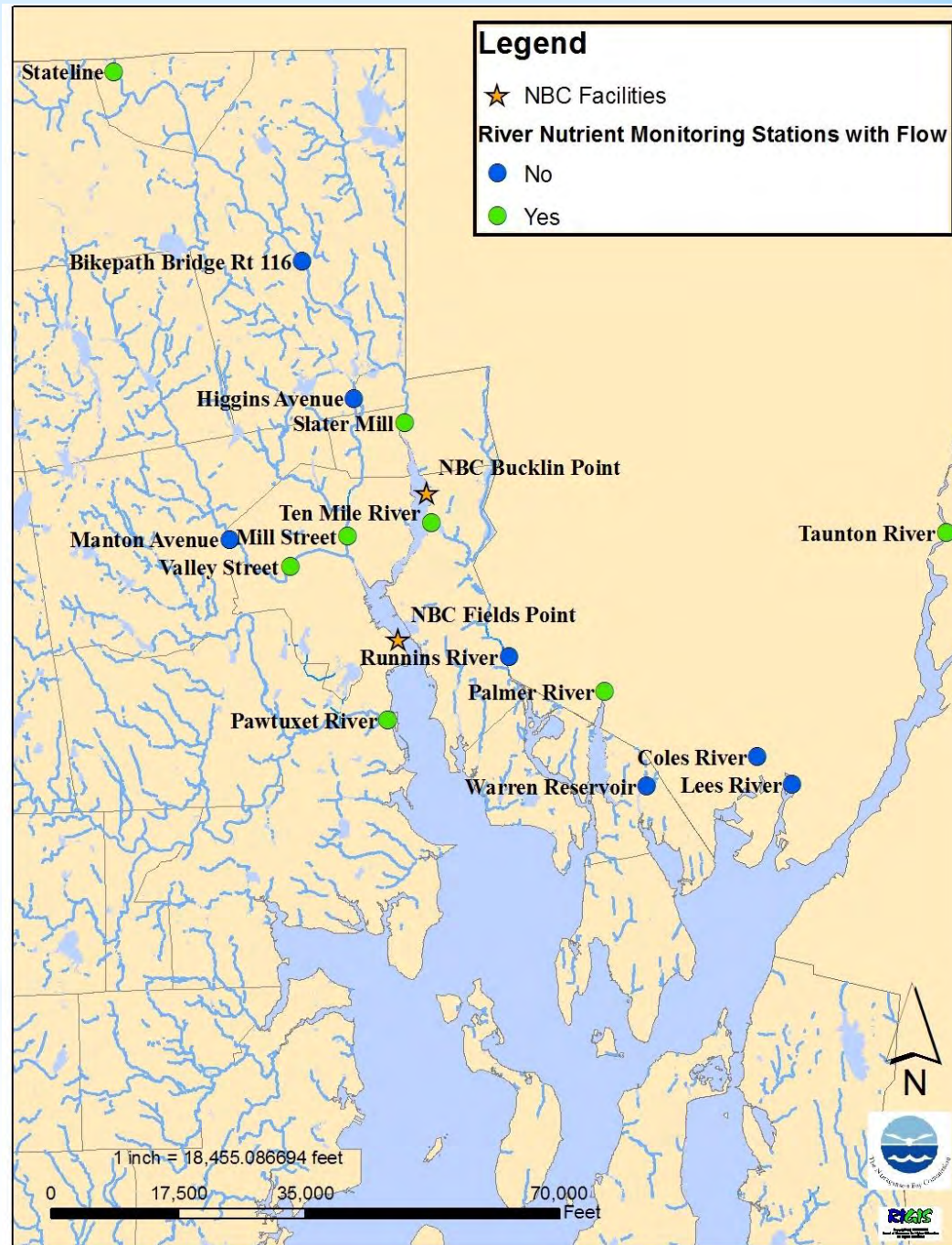
## NBC Bay Monitoring Program

- 20 NBC Bay monitoring stations in Seekonk and Providence “Rivers”
- Biweekly throughout year for fecal coliform & enterococci bacteria
- Data used to demonstrate water quality improvements and reopen shellfishing beds



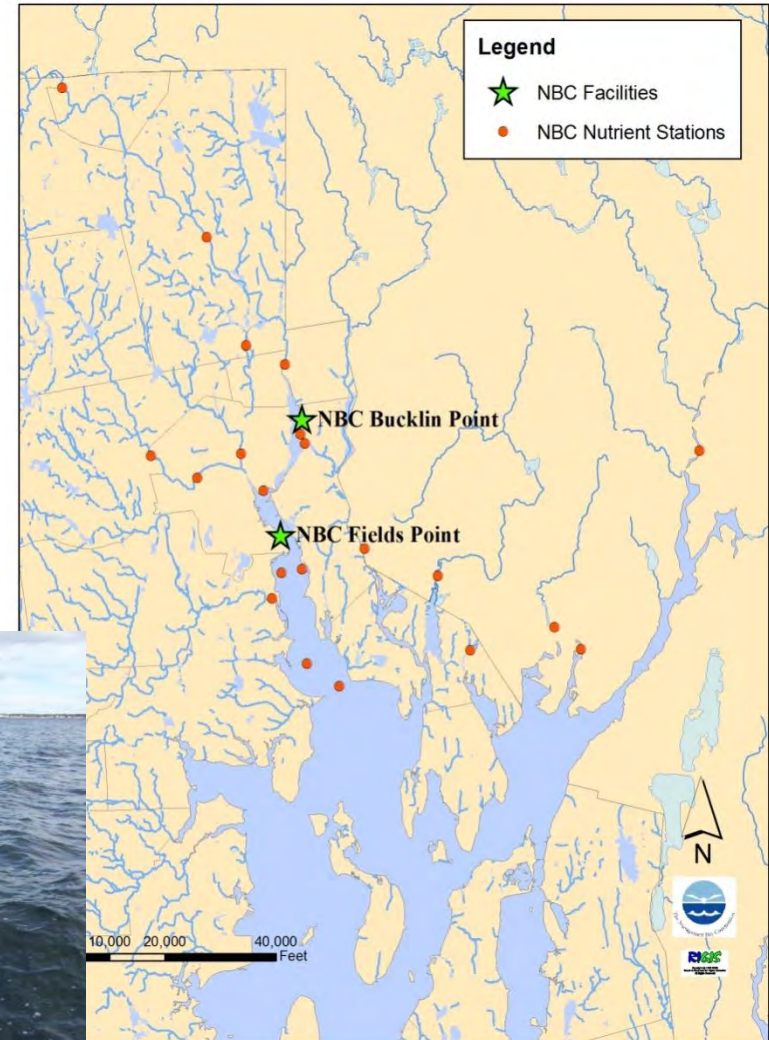
# NBC River Nutrient Stations

- Measured bi-monthly at 15 sites in RI & MA
- 3 stations on the Blackstone
- Total N loading – USGS river flow data
- Nutrient suite analyzed:
  - ✓ Nitrite/nitrate ( $\text{NO}_2/\text{NO}_3$ )
  - ✓ Nitrite ( $\text{NO}_2$ )
  - ✓ Total Dissolved Nitrogen (TDN)
  - ✓ Ammonia ( $\text{NH}_3$ )
  - ✓ Total Nitrogen (TN)
  - ✓ Orthophosphate
  - ✓ Silicate
  - ✓ Total Suspended Solids (TSS)



# Upper Bay Nutrients Monitoring

- Sample 7 sites twice monthly; perform water column profiles in conjunction with sample collections
- Evaluate sources of nitrogen loadings
- Evaluate success of nitrogen reduction efforts
- Data provides sound science to base management decisions related to need for mandated construction projects



# Upper Bay Benthic Conditions

- NBC conducts video transects in upper Bay
- NBC Staff built a camera sled/quad set-up for about \$1,000



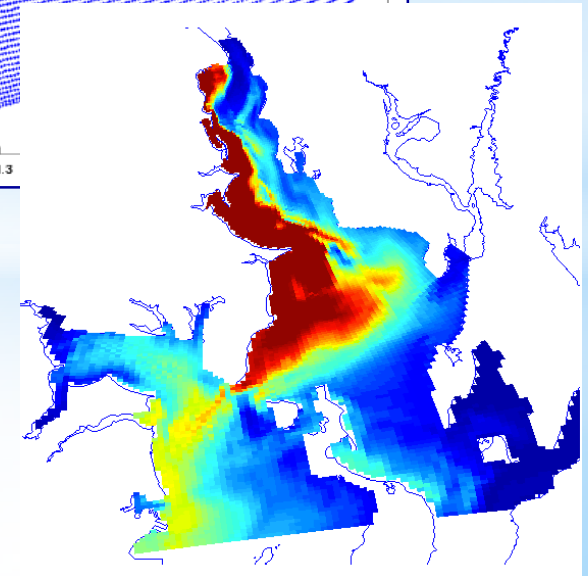
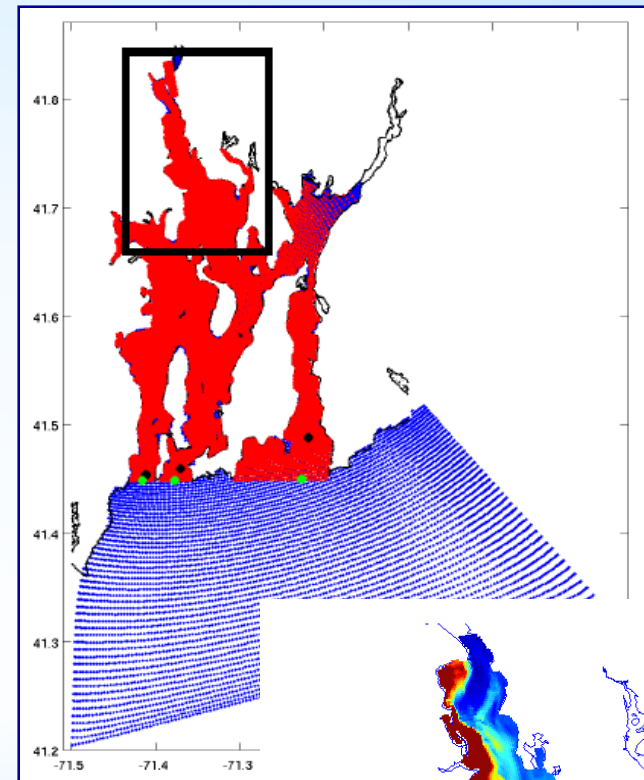
*Libinia* sp., spider crab  
between Bullock's Reach buoy and Shawomet

# Upper Bay Benthic Conditions



# Regional Ocean Modeling System

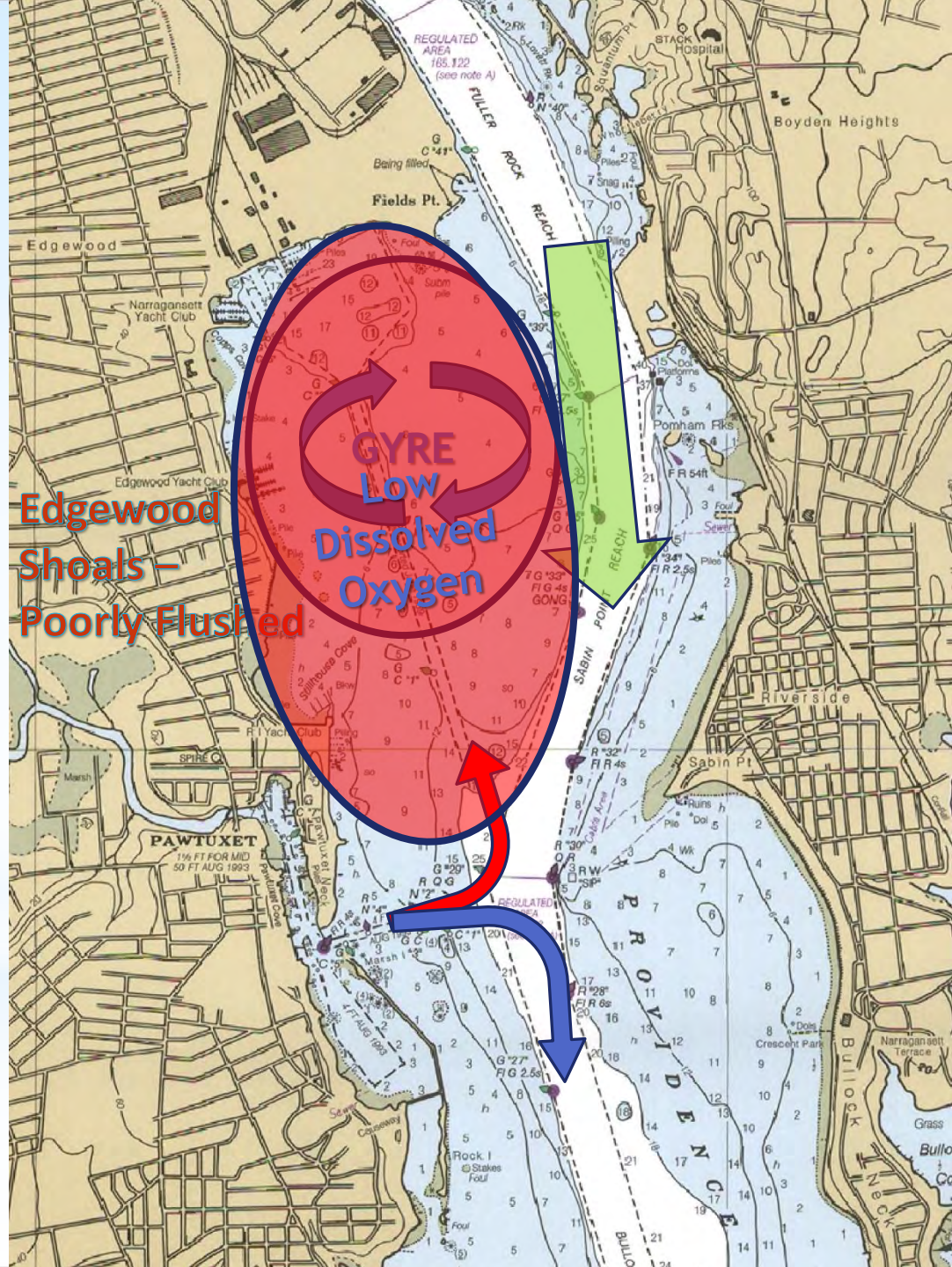
- NBC has funded ROMS public domain 3-D hydrodynamic-transport model
- Work for NBC performed by Dr. Kincaid at URI-GSO
- NBC utilizes it to:
  - ✓ Track the fate of NBC and other pollutants through the bay
  - ✓ Evaluate effectiveness of nitrogen reductions and permits mandates
  - ✓ Calculate effects of NBC projects on water quality improvements
- Latest work includes:
  - ✓ addition of the Seekonk River
  - ✓ development of an biological-oxygen model



# Water Quality Problems

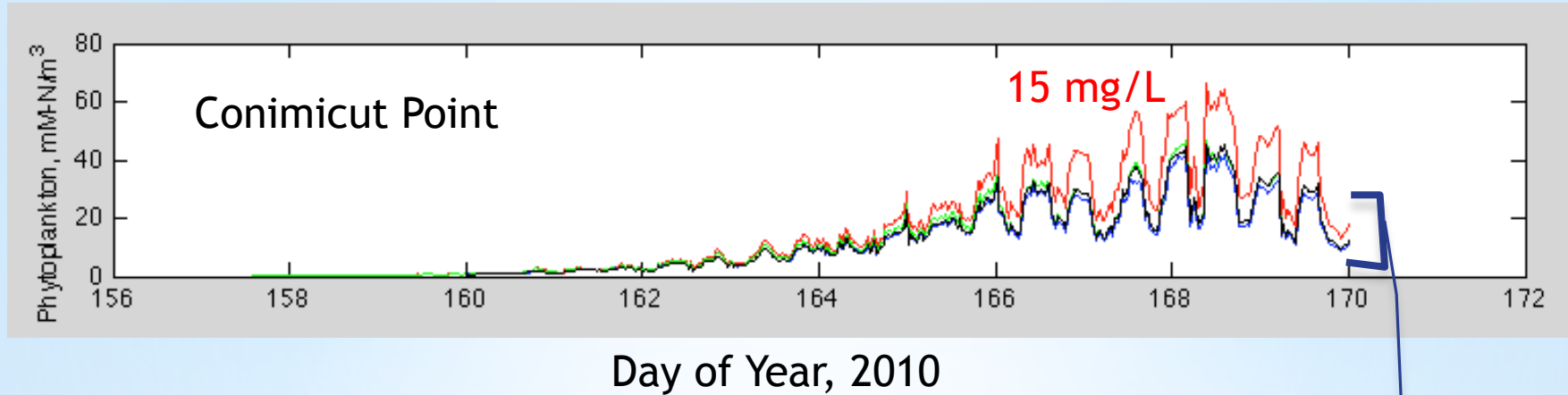
## ROMS Model Indicates:

- ✓ Jet of water down the shipping channel
- ✓ Sets up a clockwise Gyre on Shoal
- ✓ **Bottom waters** from Pawtuxet River transport Nitrogen onto the shoal





# Phytoplankton Levels vs Time for Various Effluent TN Levels For All WWTFs



ROMS simulated WWTF TN reductions of 5 to 3 to 0 mg/L show very limited impact on phytoplankton levels

WWTF TN Levels:

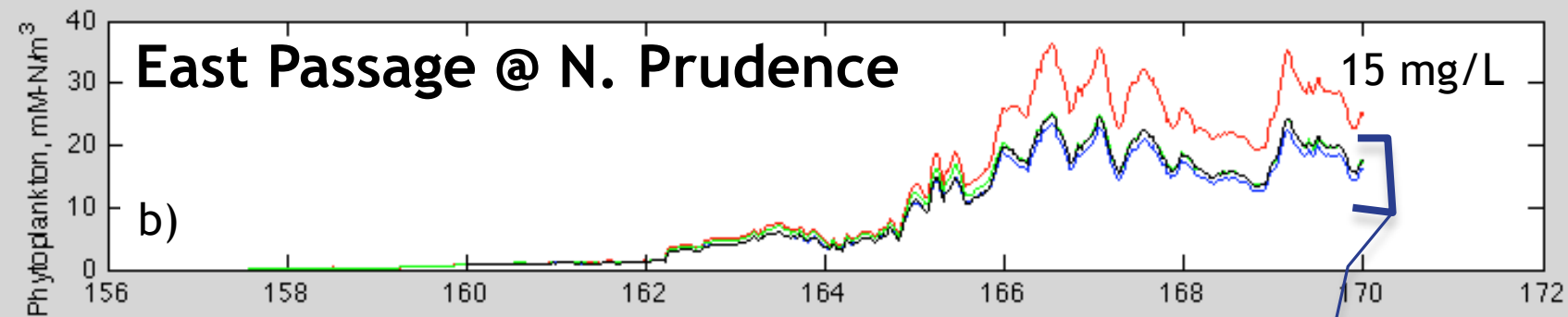
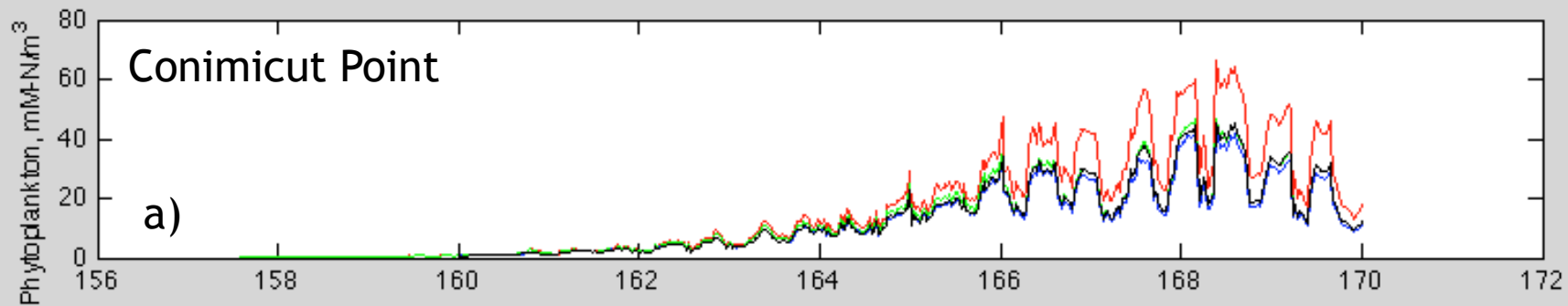
Red=15 mg/L

Green: 5 mg/L

Blue: 3 mg/L

Black: 0 mg/L

# Phytoplankton Levels vs Time for Various Effluent TN Levels For All WWTFs



WWTF TN Levels:

Red=15 mg/L

Green: 5 mg/L

Blue: 3 mg/L

Black: 0 mg/L

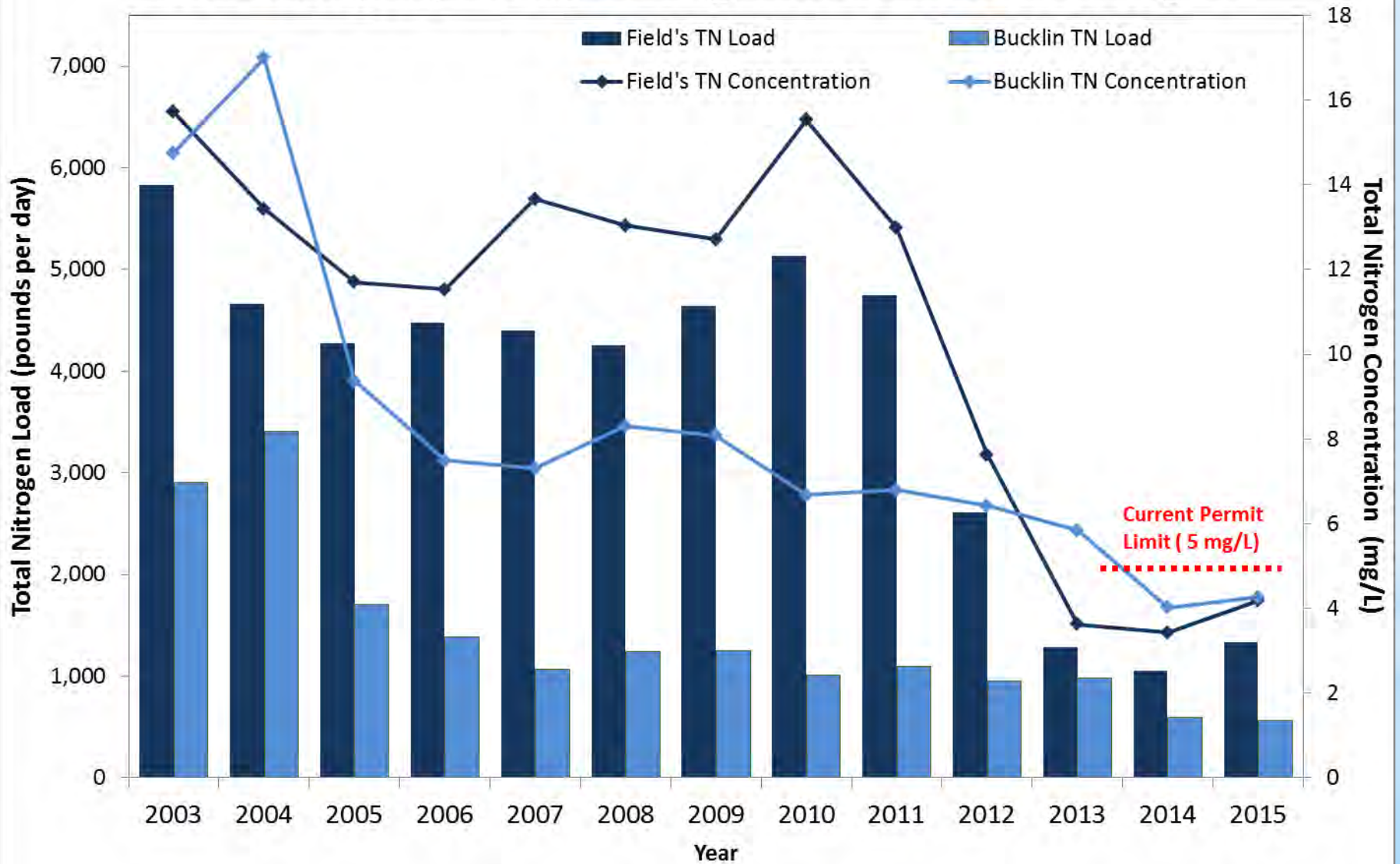
TN Reductions less than 5 mg/L do not produce significant change in phytoplankton levels



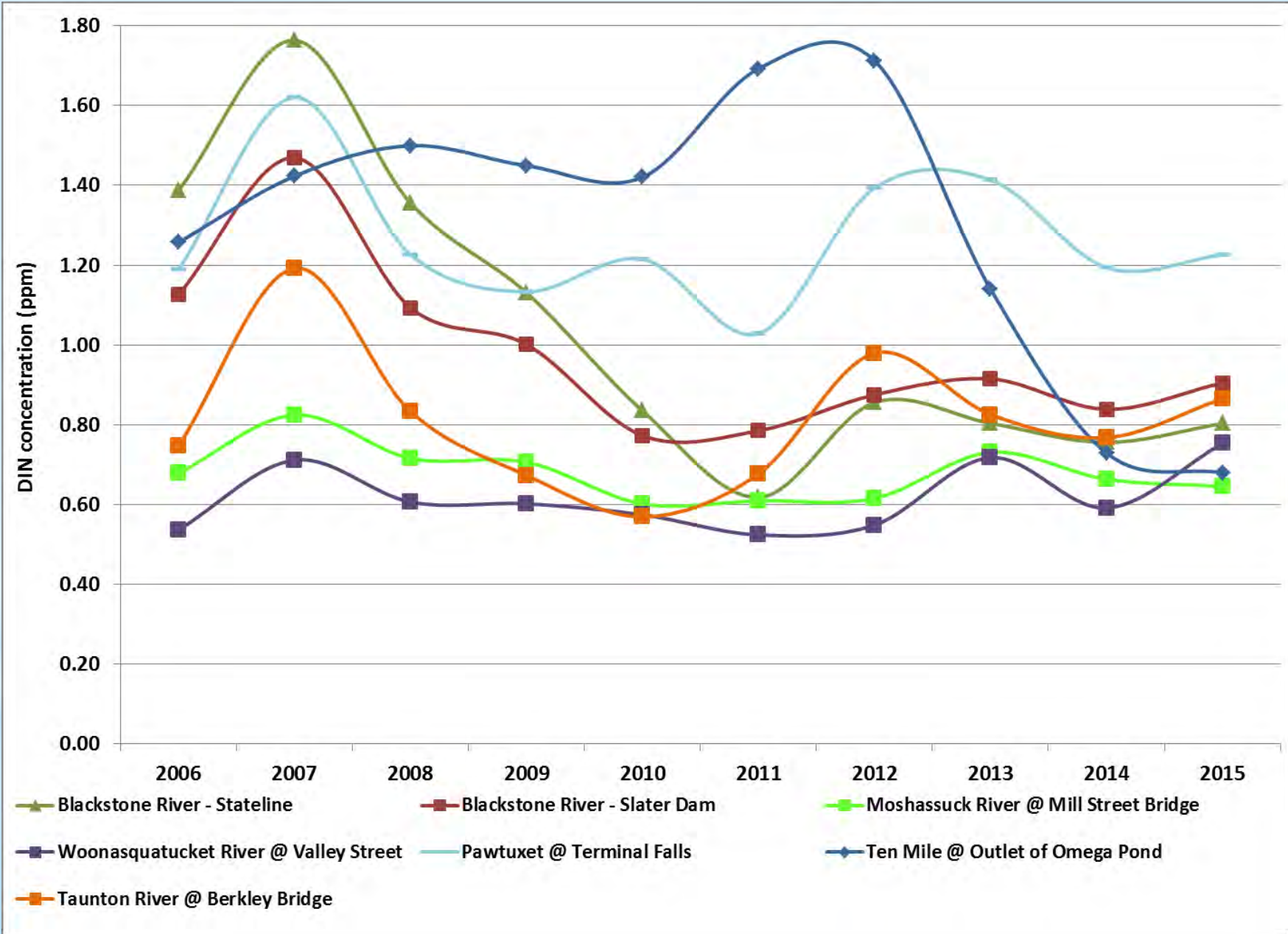
***NBC Monitoring Findings:  
Effect of Nitrogen Reductions on Rivers  
and Upper Bay***

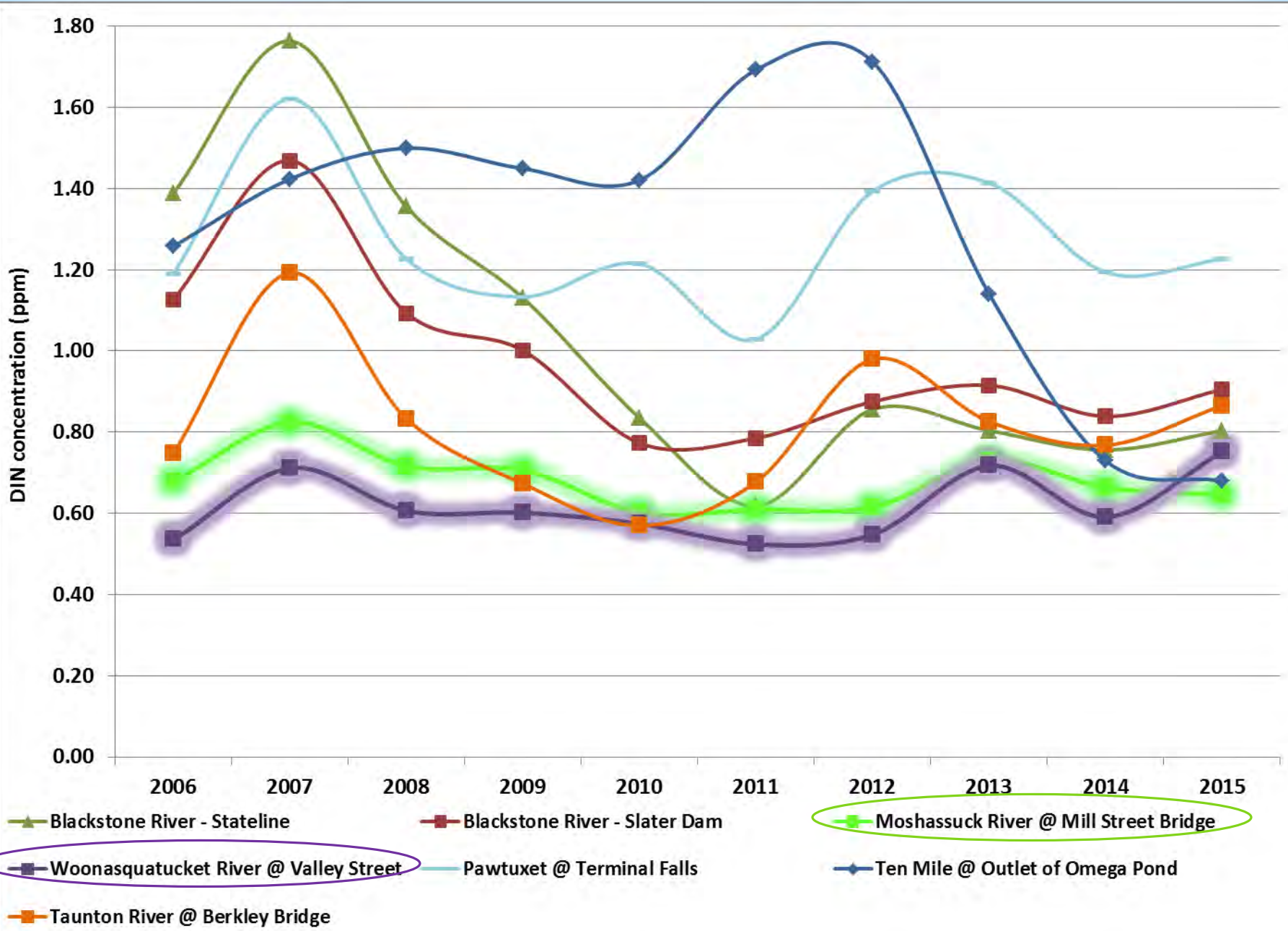
# Field's Point & Bucklin Point

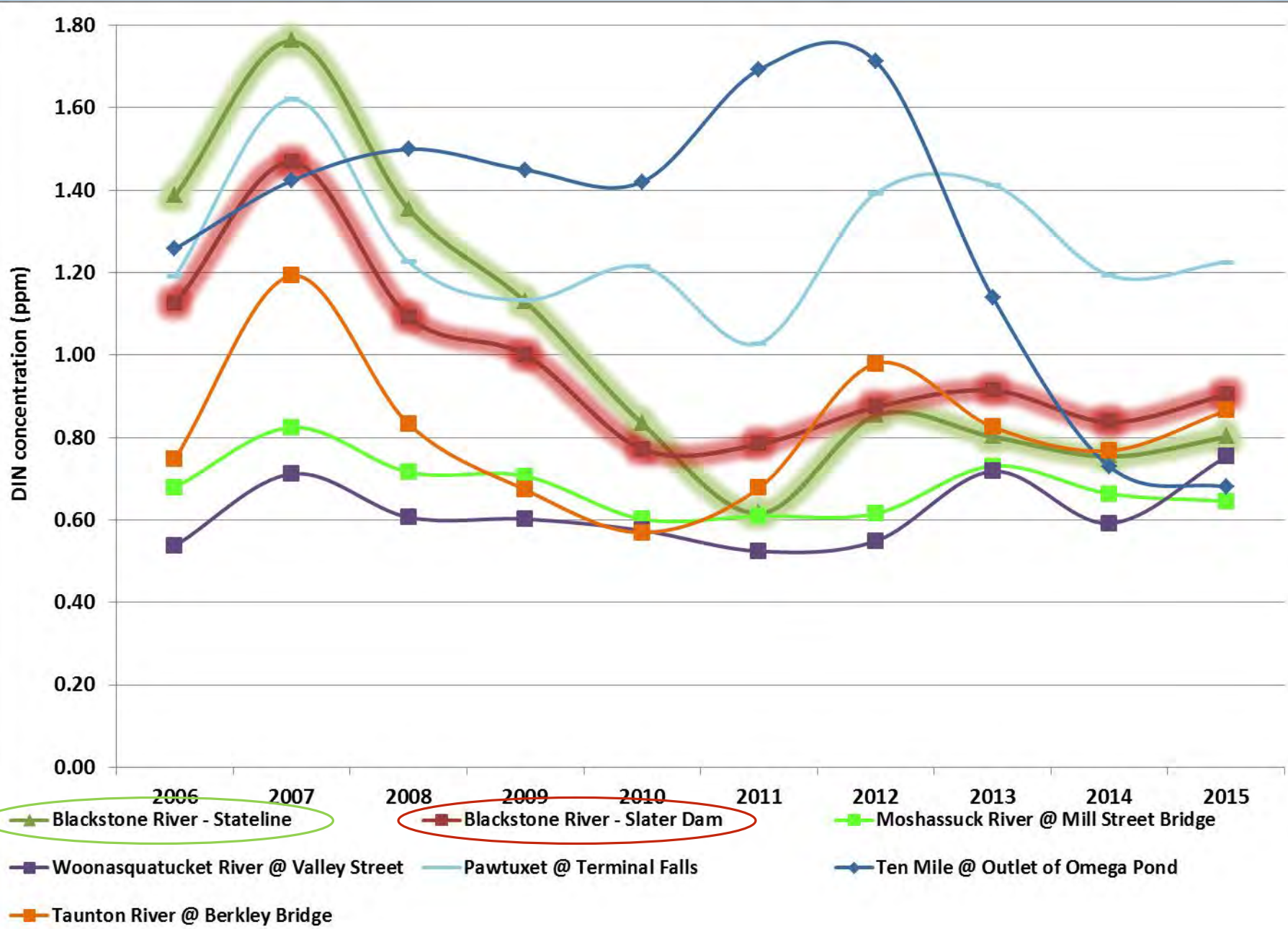
## Seasonal (May - Oct) Average Effluent Total Nitrogen

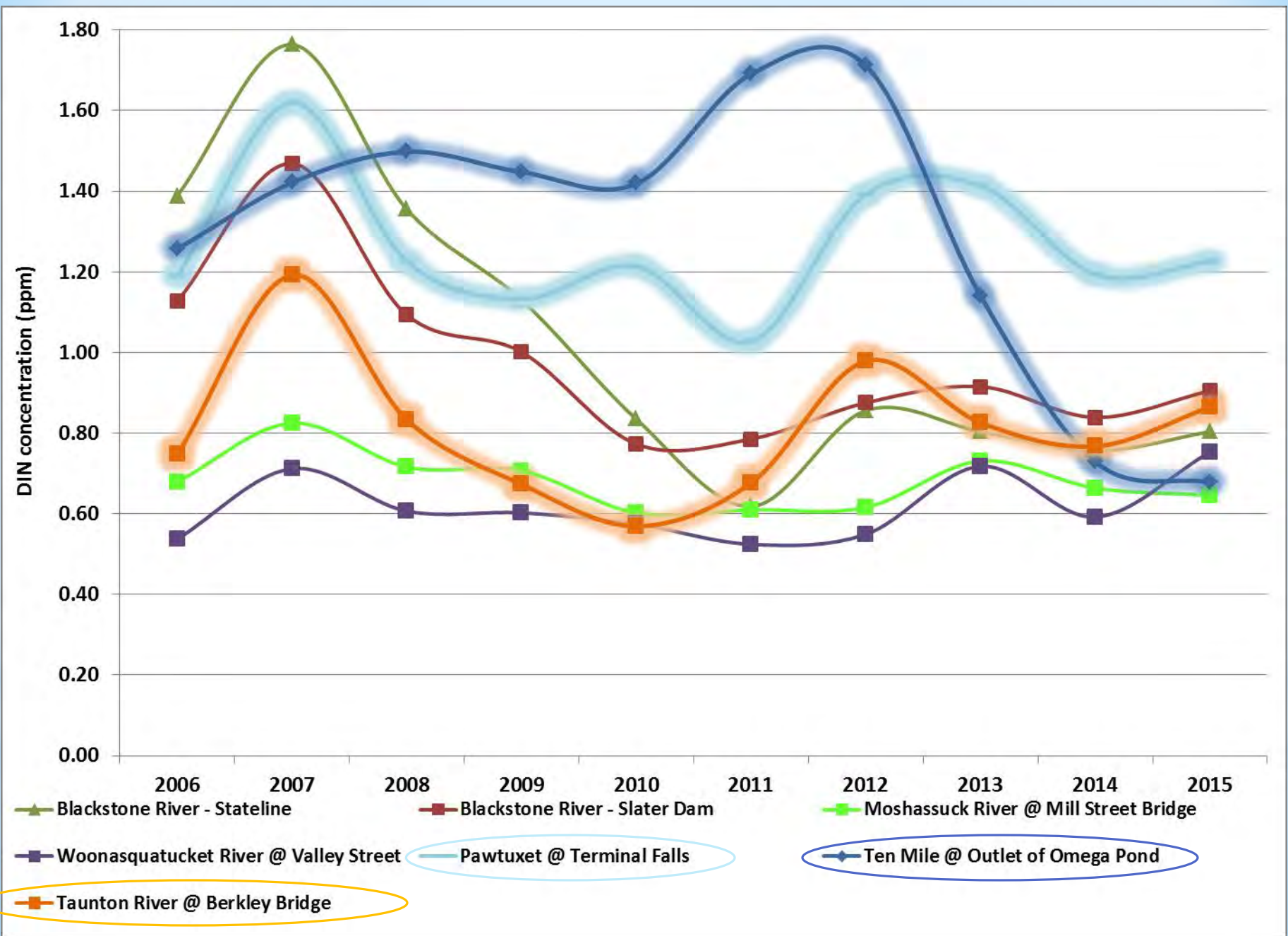


# Annual River DIN Concentrations



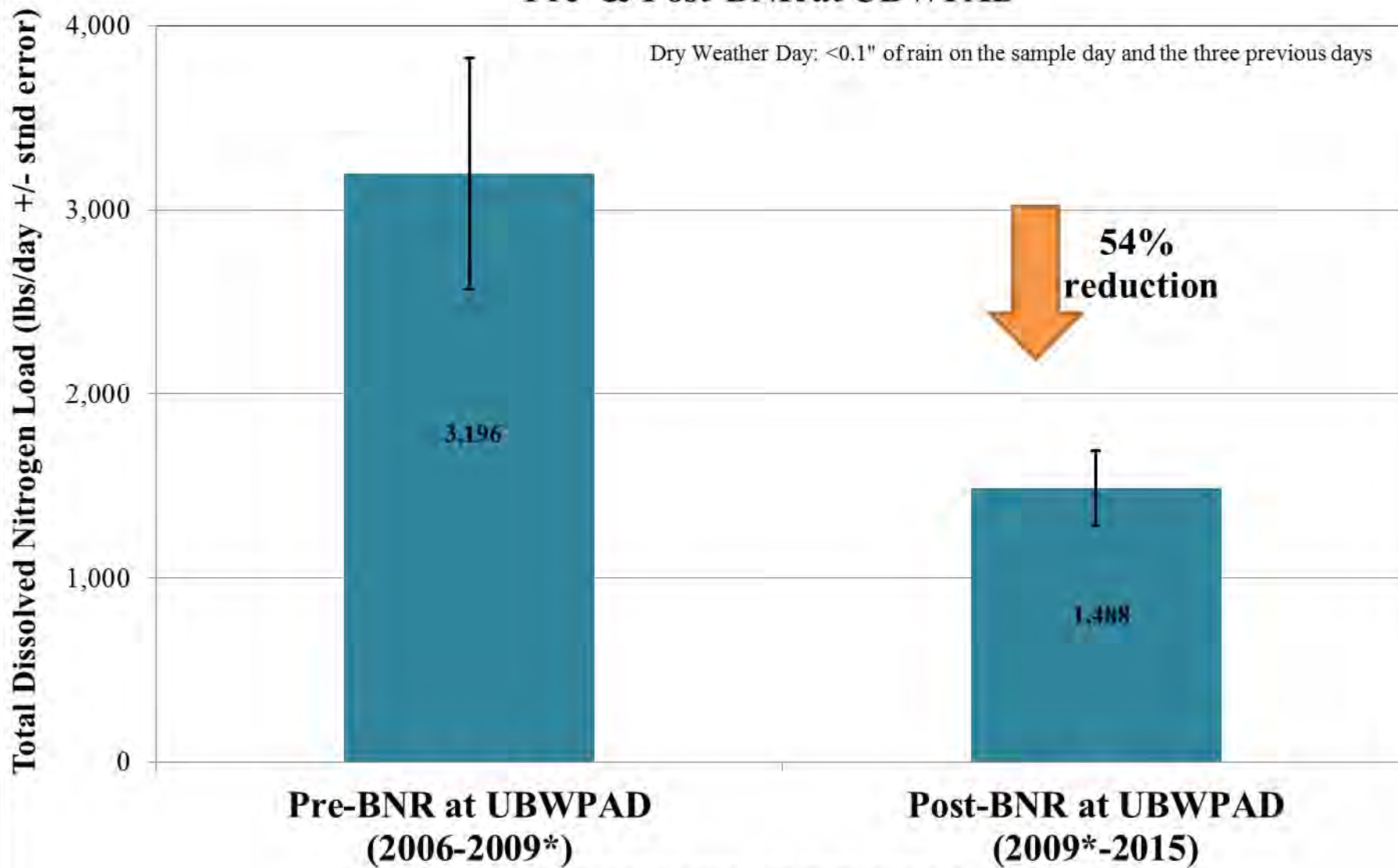






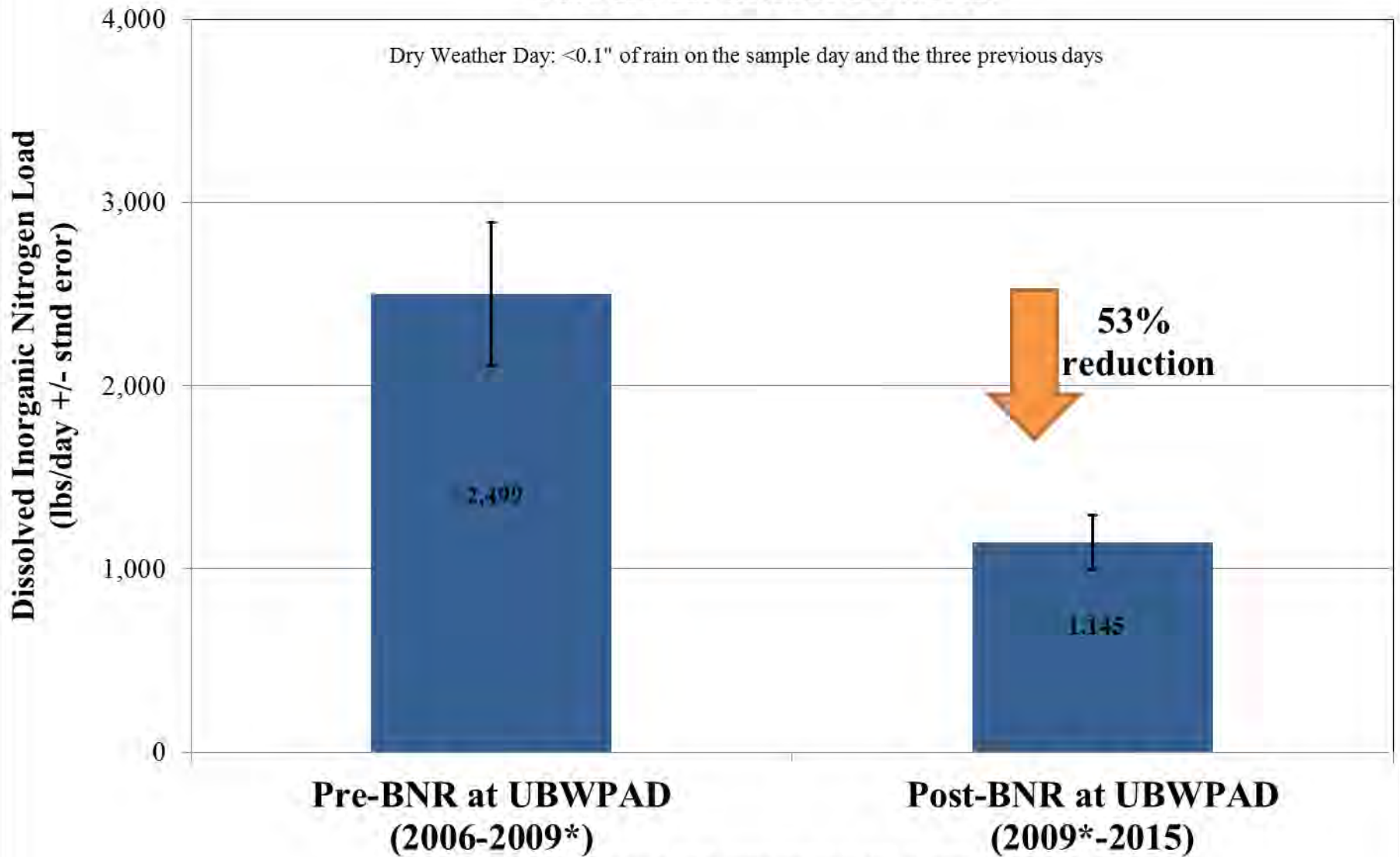


# Seasonal (May - Oct) Dry Weather Total Dissolved Nitrogen Loading Blackstone River at the MA/RI Stateline Pre- & Post-BNR at UBWPAD



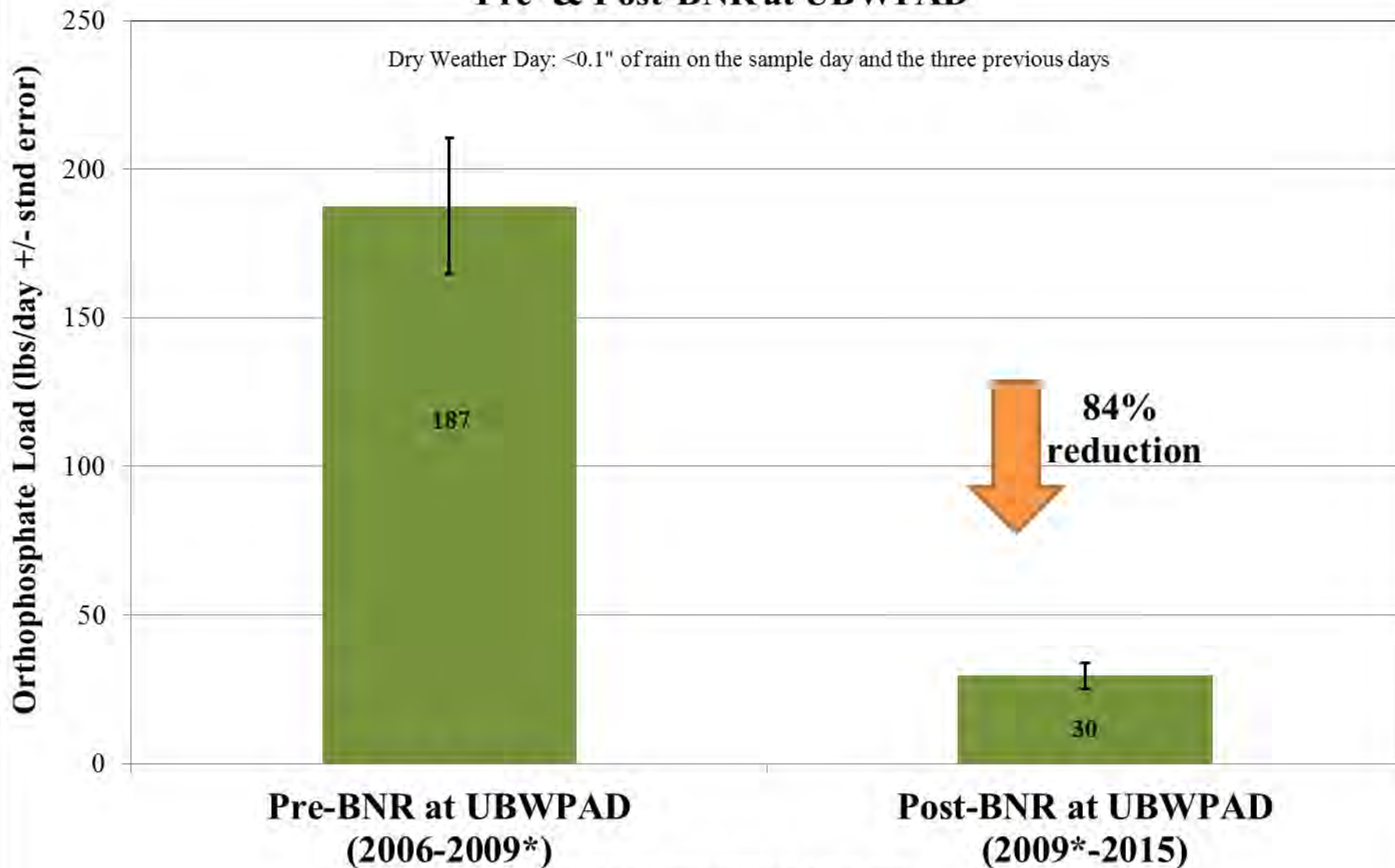
\*UBWPAD BNR came online in fall of 2009

# Seasonal (May - Oct) Dry Weather Dissolved Inorganic Nitrogen Loading Blackstone River at the MA/RI Stateline Pre- & Post-BNR at UBWPAD



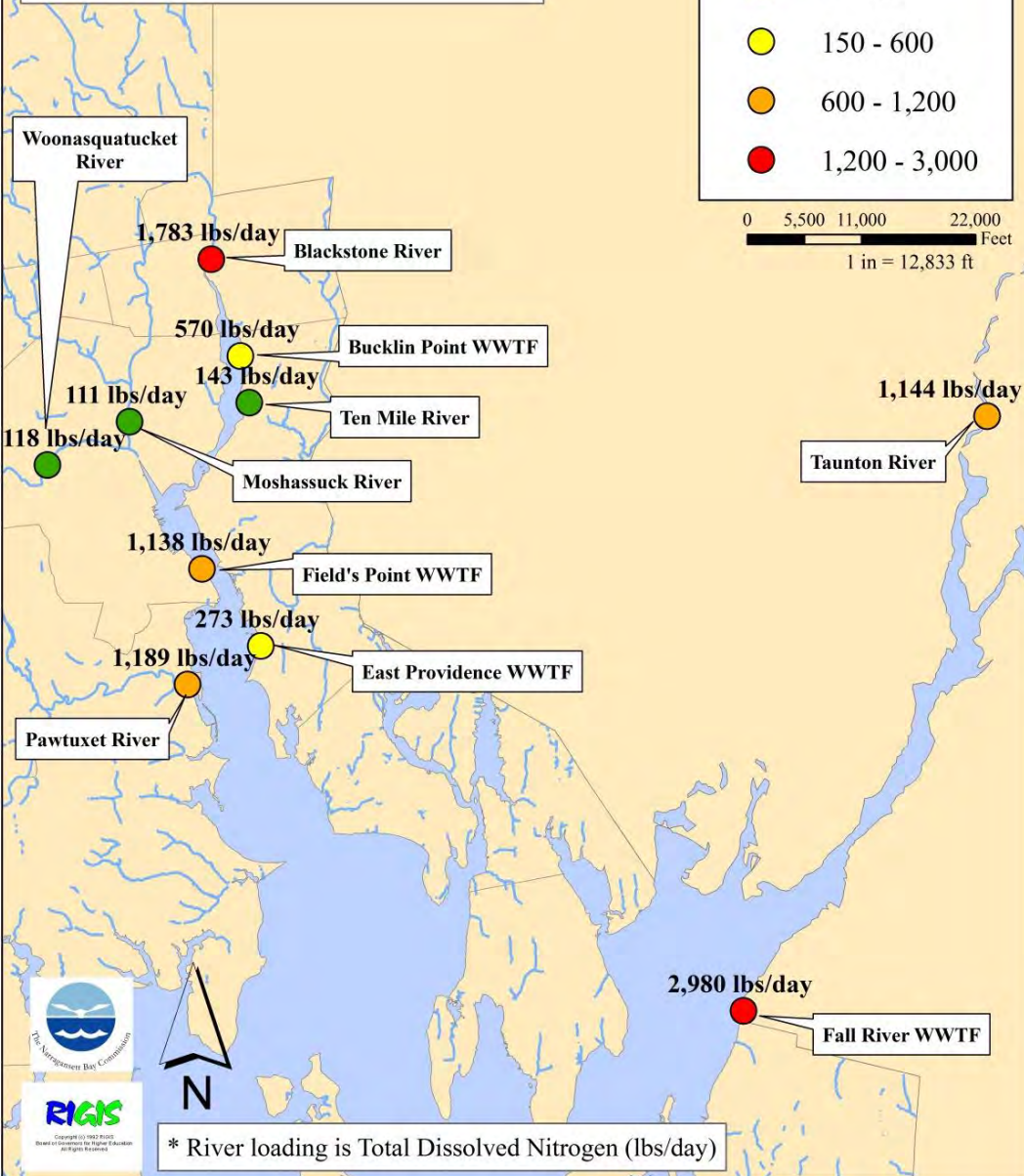
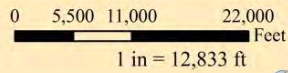
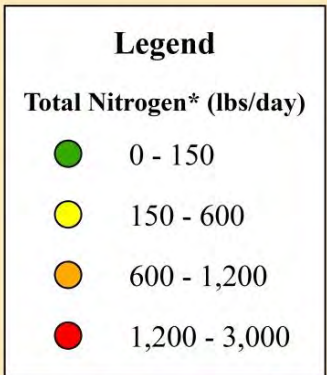
\*UBWPAD BNR came online in fall of 2009

# Seasonal (May - Oct) Dry Weather Orthophosphorus Loading Blackstone River at the MA/RI Stateline Pre- & Post-BNR at UBWPAD



\*UBWPAD BNR came online in fall of 2009

**Narragansett Bay Commission**  
**Average Seasonal Nutrient Loading**  
**May - Oct**  
**2014 - 2015**



\* River loading is Total Dissolved Nitrogen (lbs/day)

# Seasonal (May – Oct) Total Nitrogen/TDN Loading from Upper Bay Rivers & WWTPs

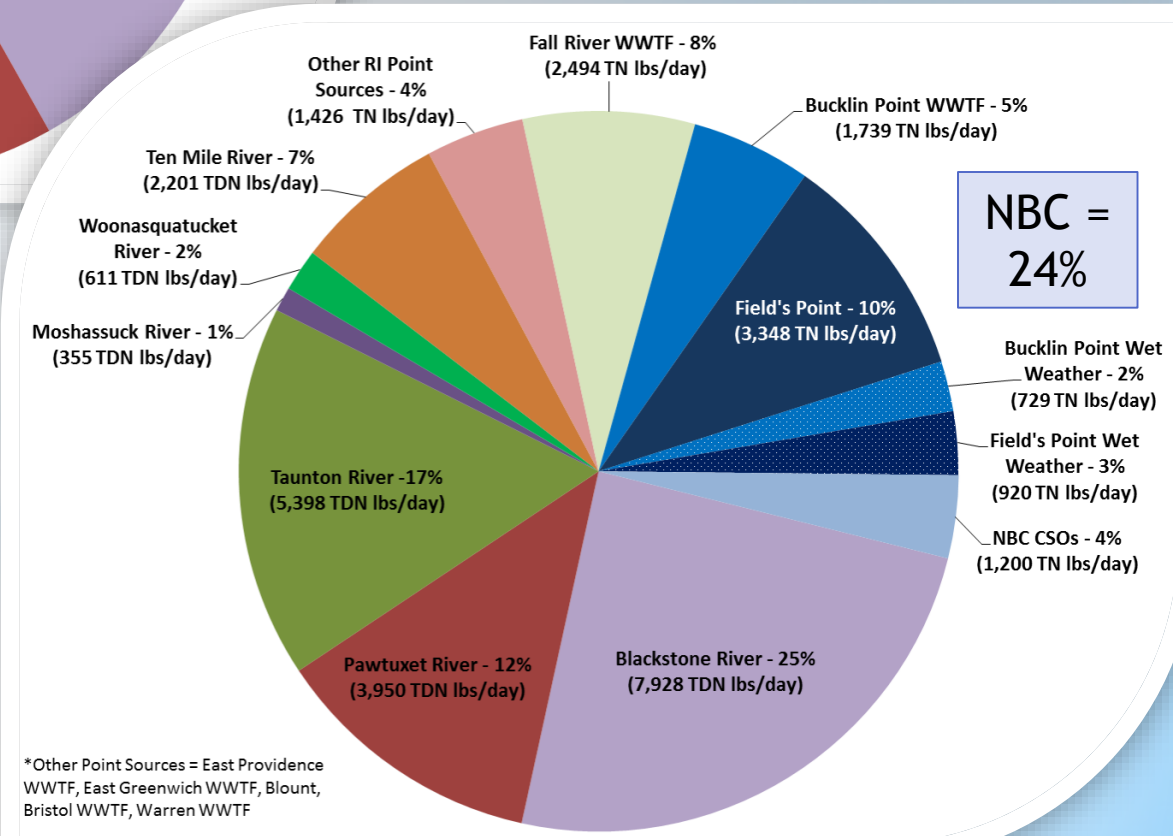
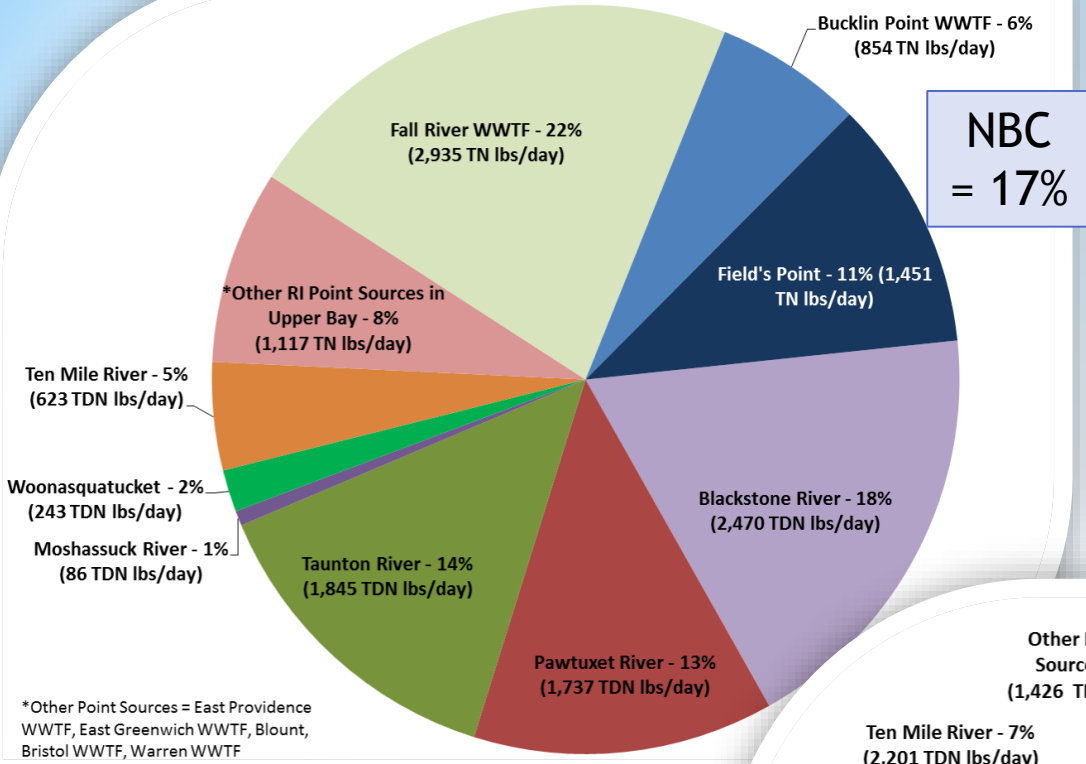
	2006-2013 Average Values	2014 - 2015 Average Values
Source	Pounds	Pounds
Bucklin Point	1,188	570
Field's Point	3,986	1,138
Blackstone River	4,424	1,783
Moshassuck River	175	111
Woonasquatucket River	426	118
Pawtuxet River	2,247	1,189
Ten Mile River	816	143
East Providence WWTP*	517	265
Taunton River	2,723	1,144
Fall River WWTP*	3,227	2,980
Other Sources TOTAL**	844	997
<b>Total Contribution</b>	<b>20,573</b>	<b>10,438</b>

\*Data for East Providence and Fall River is for May - September

\*\*"Other Sources" includes the East Greenwich, Bristol, and Warren WWTP.

## Decrease of 49.3% since 2006

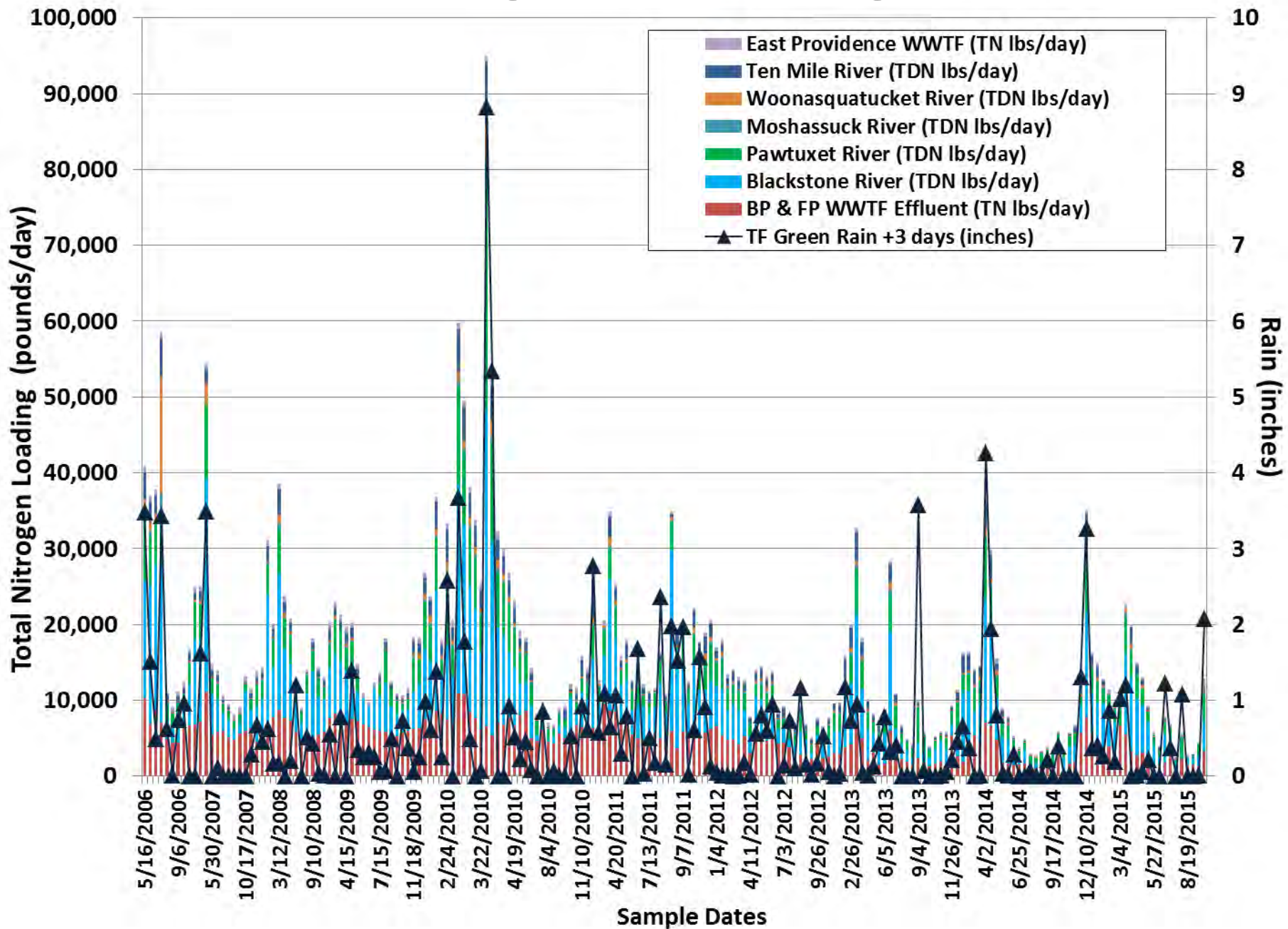
# 2013 – 2014 Annual Average Loads



**DRY Weather Days**  
<0.1 inch of rain over prev. 3days

**WET Weather Days**

# Total Nitrogen Loading & Rain



# National Coastal Condition Report III



## Nitrogen TMDL has NOT been Developed Yet!!! So...





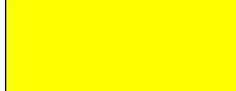





**Table I-2. Criteria for Assessing Dissolved Inorganic Nitrogen (DIN)**

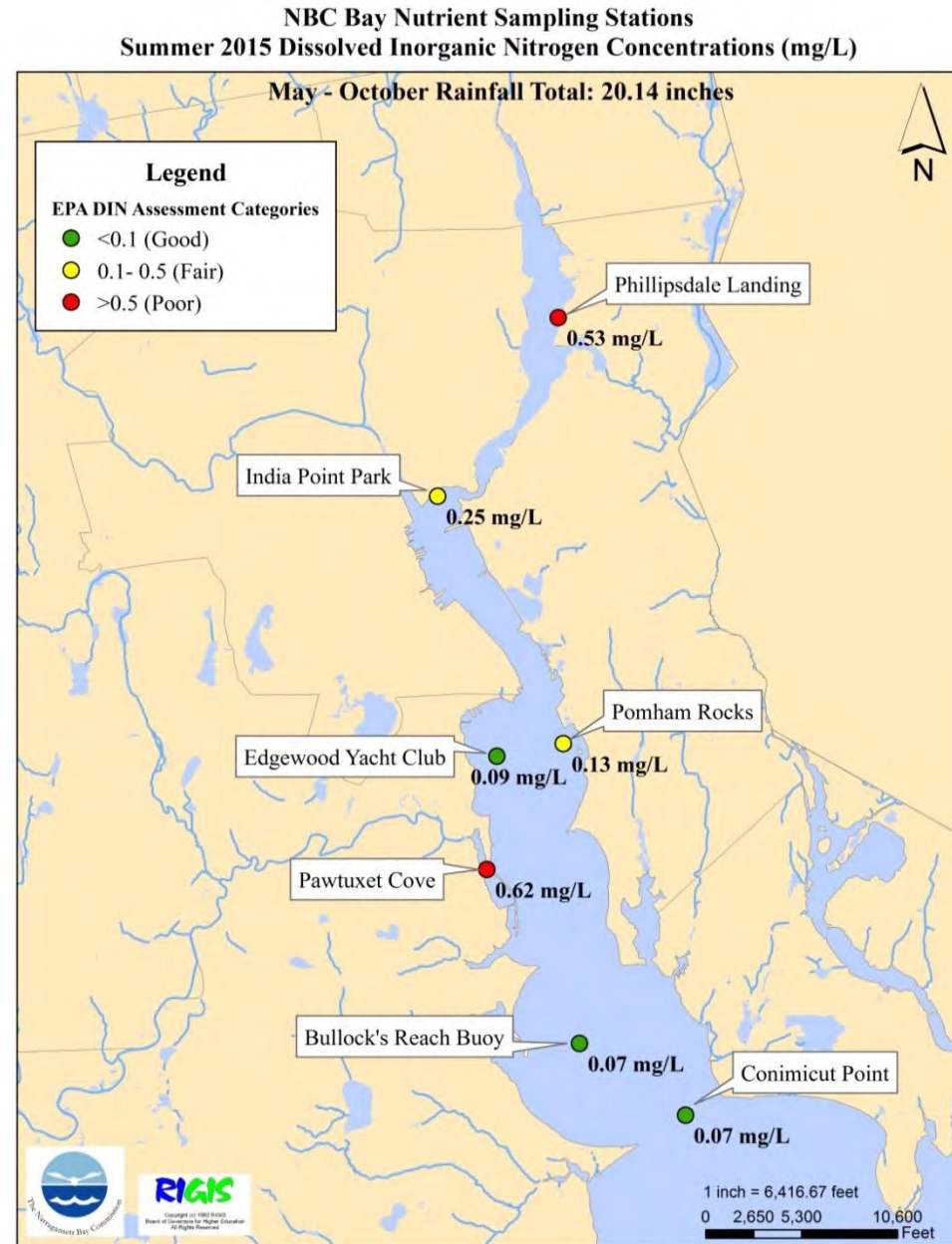
Area	Good	Fair	Poor
Northeast, Southeast, and Gulf Coast sites	< 0.1 mg/L	0.1–0.5 mg/L	> 0.5 mg/L
West Coast and Alaska sites	< 0.5 mg/L	0.5–1.0 mg/L	> 1 mg/L
Hawaii, Puerto Rico, and Florida Bay sites	< 0.05 mg/L	0.05–0.1 mg/L	> 0.1 mg/L
<b>Regions</b>	Less than 10% of the coastal area is in poor condition,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

# 2015 Surface DIN

May – October 2015

Rainfall Total: 20.14 inches

 Good <0.1  Fair 0.1-0.5  Poor >0.5 <b>Station</b>	DIN (mg/L)	EPA CCR Category
Phillipsdale Landing	0.53	
India Point Park	0.25	
Edgewood Yacht Club	0.09	
Pomham Rocks	0.13	
Pawtuxet Cove	0.62	
Bullock's Reach	0.07	
Conimicut Point	0.07	

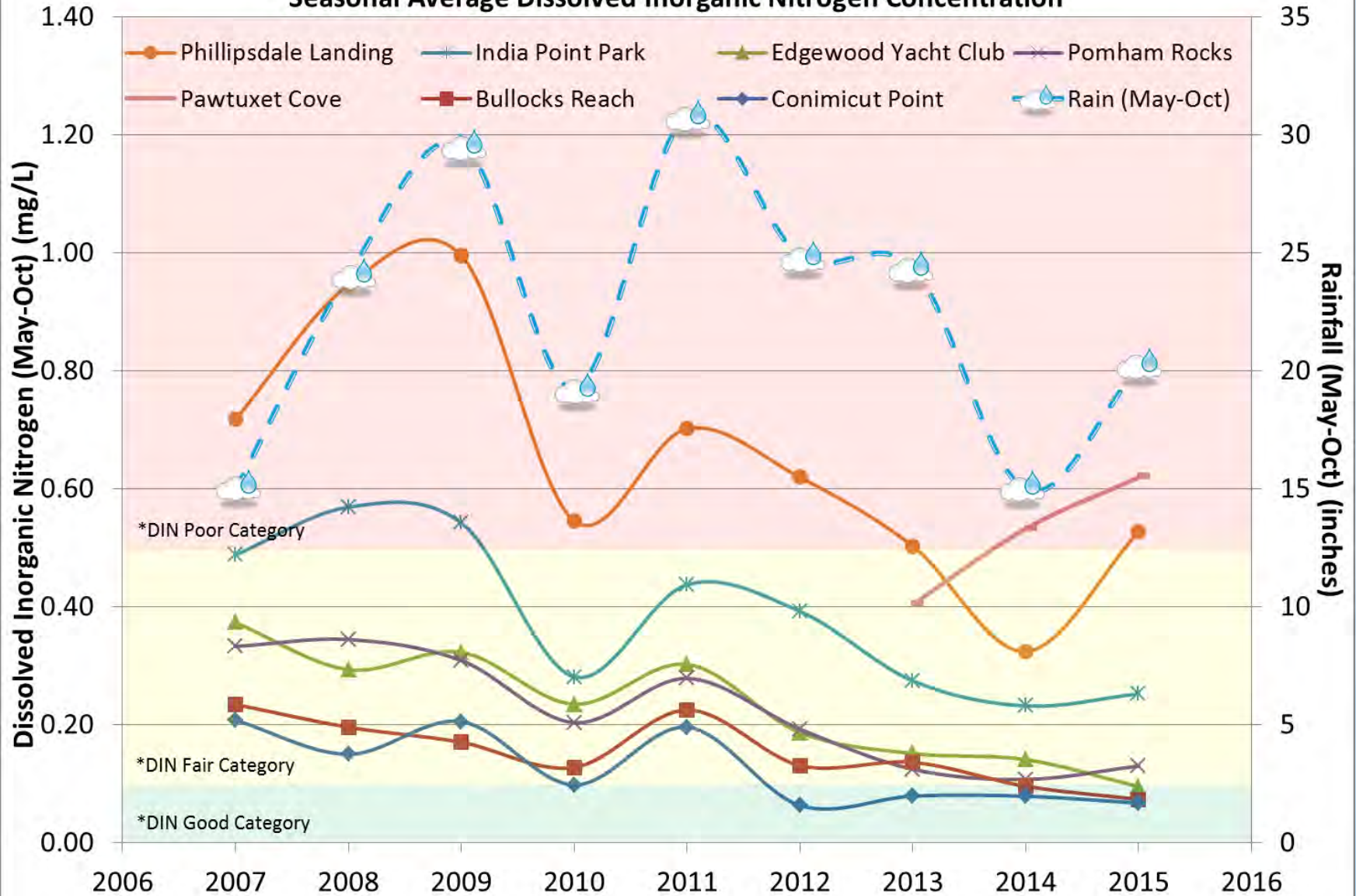




# Surface DIN & Rainfall

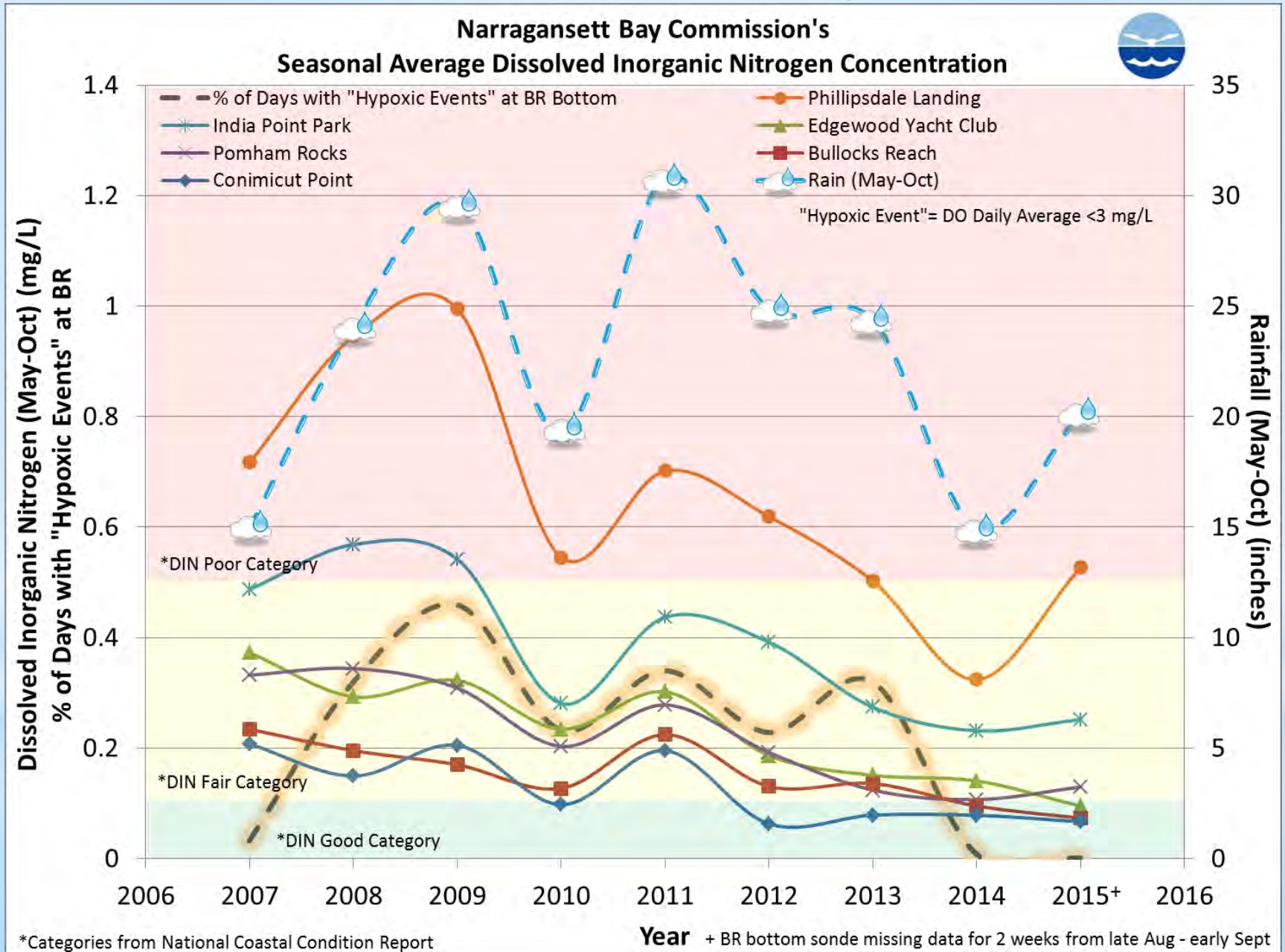
Narragansett Bay Commission's

Seasonal Average Dissolved Inorganic Nitrogen Concentration



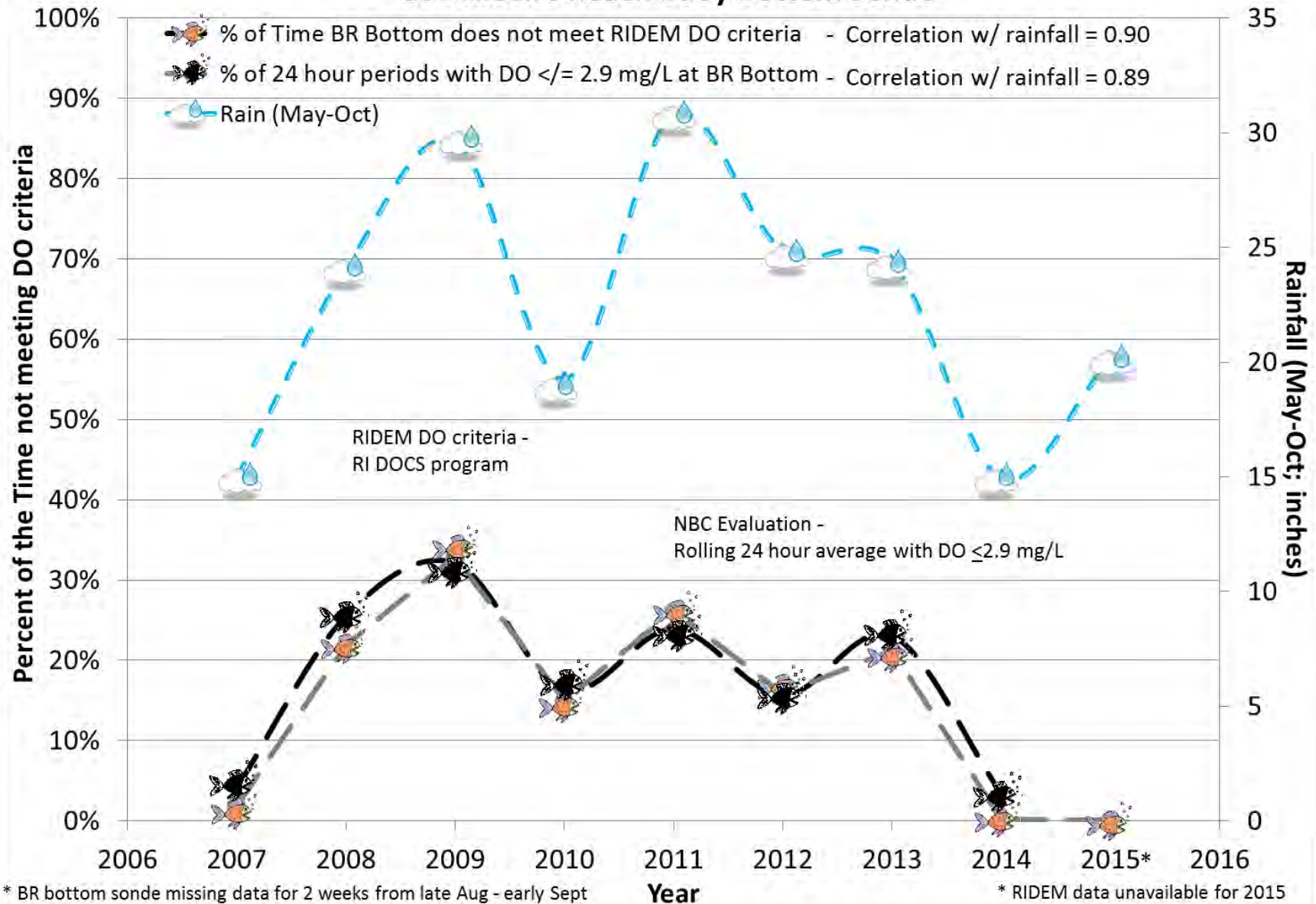
\*Categories from National Coastal Condition Report

# Surface DIN & Hypoxia



# Hypoxia & Rainfall

## Correlation between Hypoxia and Rainfall at Bullock's Reach Buoy Bottom Sonde





***NBC Monitoring Findings:  
Effect of NBC CSO Abatement Program  
on Urban Rivers and Upper Bay***

# Pollutants Removed Due To Tunnel

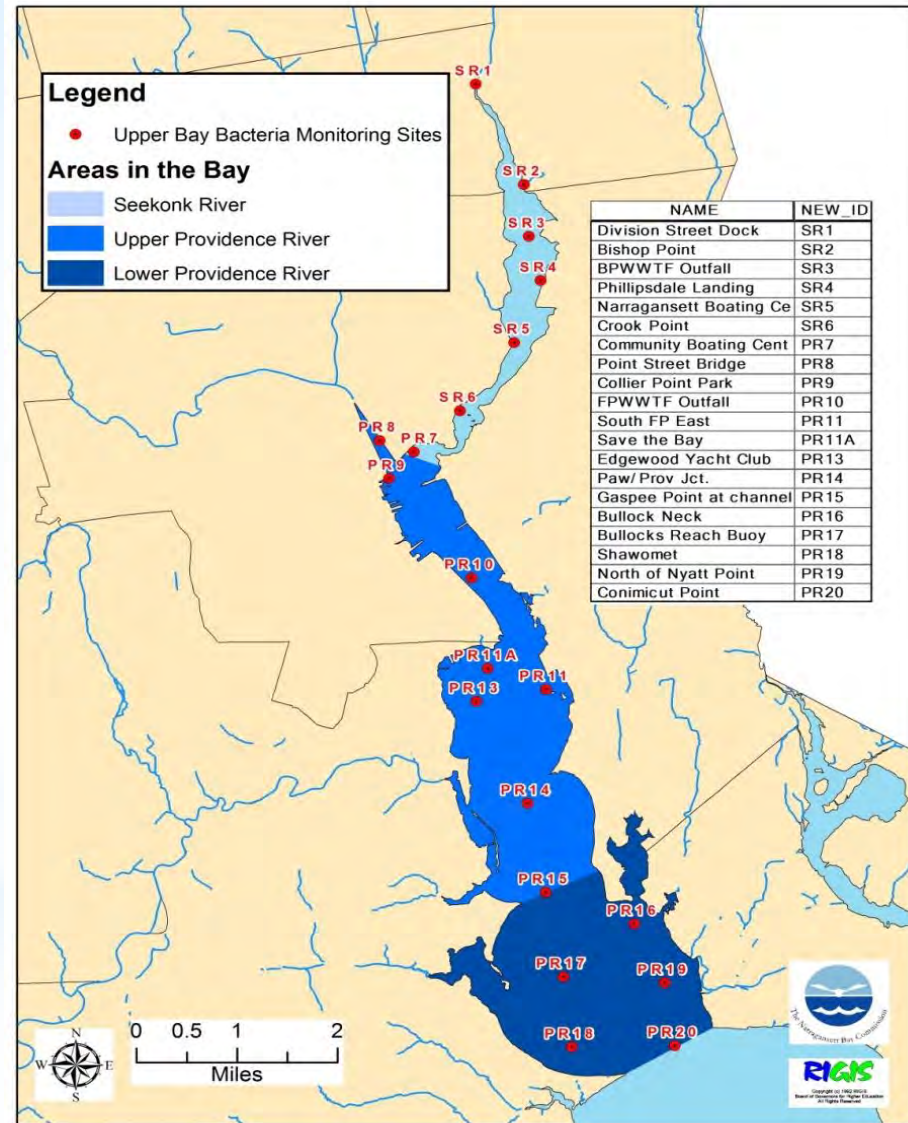
- Tunnel captured 6.6 billion gallons of CSO flow over past 6+ years (through 10/29/15)
- Flow is pumped to FP WWTF & receives full secondary & tertiary treatment
- ~1.1 billion gallons/year captured
  - ✓ 50% of the CSO volume captured and treated annually (based on design model)
  - ✓ 50% Bacteria Load Reduction!!!
- Millions of pounds of pollutants prevented from being discharged
  - ✓ >2.5 Million Pounds TSS
  - ✓ >1.6 Million Pounds BOD
  - ✓ ~260,000 Pounds Nitrogen
  - ✓ >83,000 Pounds of Metals

Contaminant	Average Concentration CSO Tunnel Effluent		Total Pounds Removed by Capture in Tunnel & Treatment at Field's Point
Total Volume Captured in Tunnel	6,634,000,000 gallons		
Total Suspended Solids	52.18	mg/L	2,580,929
Biochemical Oxygen Demand	32.15	mg/L	1,654,025
Total Nitrogen	8.50	mg/L	260,722
Cyanide	6.29	µg/L	268
Aluminum	240	µg/L	12,566
Cadmium	1.27	µg/L	66
Chromium	5.67	µg/L	272
Copper	11.52	µg/L	535
Iron	1,432	µg/L	67,632
Lead	9.38	µg/L	471
Nickel	17.48	µg/L	298
Silver	2.02	µg/L	107
Zinc	31	µg/L	1,281

# NBC Bay Bacteria Sampling

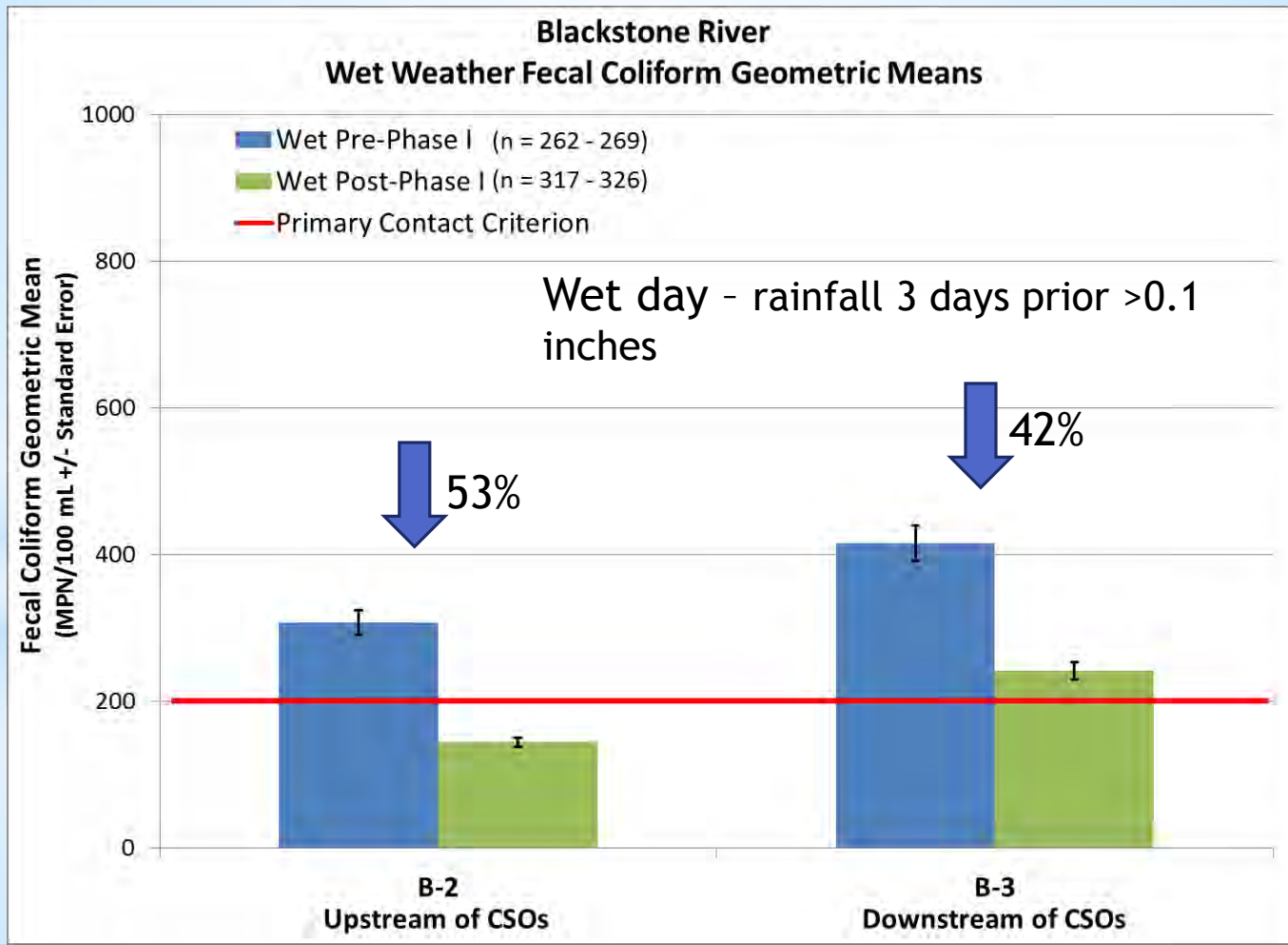
- ✓ 20 sites sampled in Providence & Seekonk Rivers every other week
- ✓ Analyzed for fecal coliform
- ✓ 25% of samplings also analyzed for Enterococci
- ✓ Several storm events sampled annually to evaluate bay water quality improvements (tunnel)
- ✓ Periodically sample shellfishing areas in cooperation with DEM
- ✓ Visit NBC's website for results:

<http://snapshot.narrabay.com/app/>



# Blackstone River Fecal Coliform

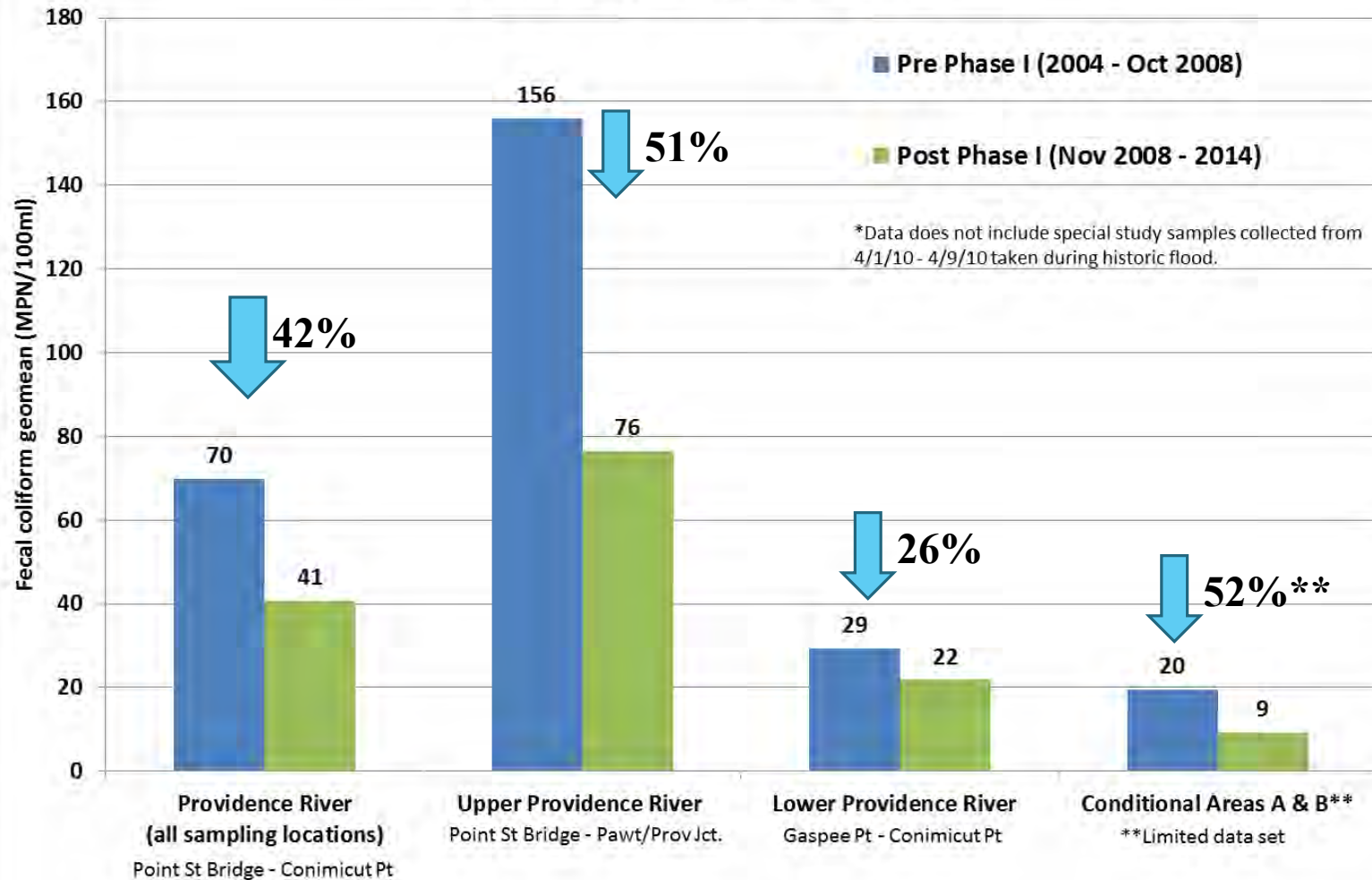
- ✓ BR not addressed in Phase I of NBC CSO Abatement Program
- ✓ Evaluated for comparison to rivers & for Phase III assessment
- ✓ Pre-Phase I (2004 – Oct 2008), Post-Phase I (Nov 2008 – 2014)



# Upper Bay Bacteria Data Analysis

## Providence River – All Weather

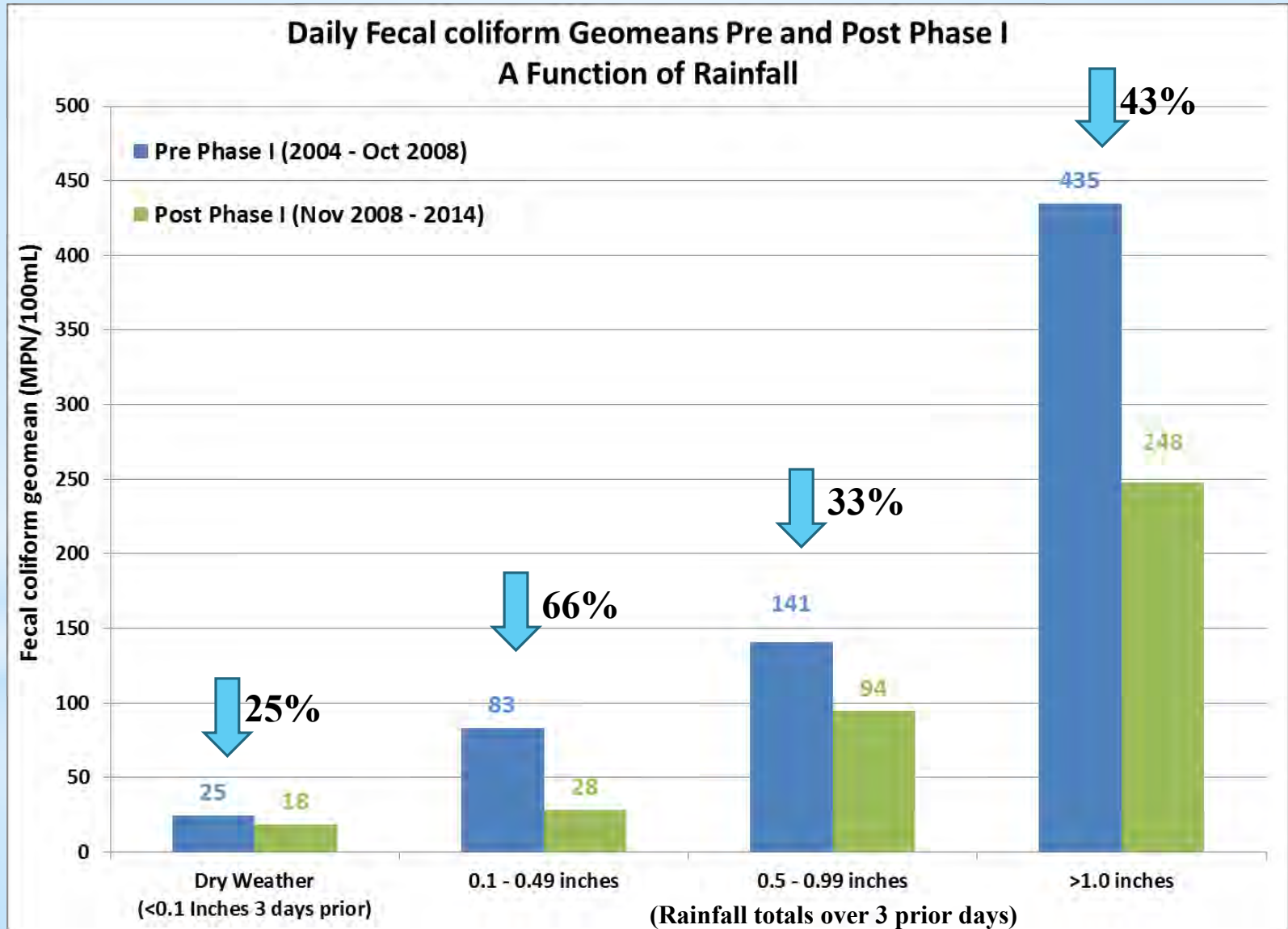
Providence River/Upper Bay Fecal coliform Geomeans  
Pre and Post Tunnel Operation





# Upper Bay Bacteria Data Analysis

## Providence River – Wet Weather

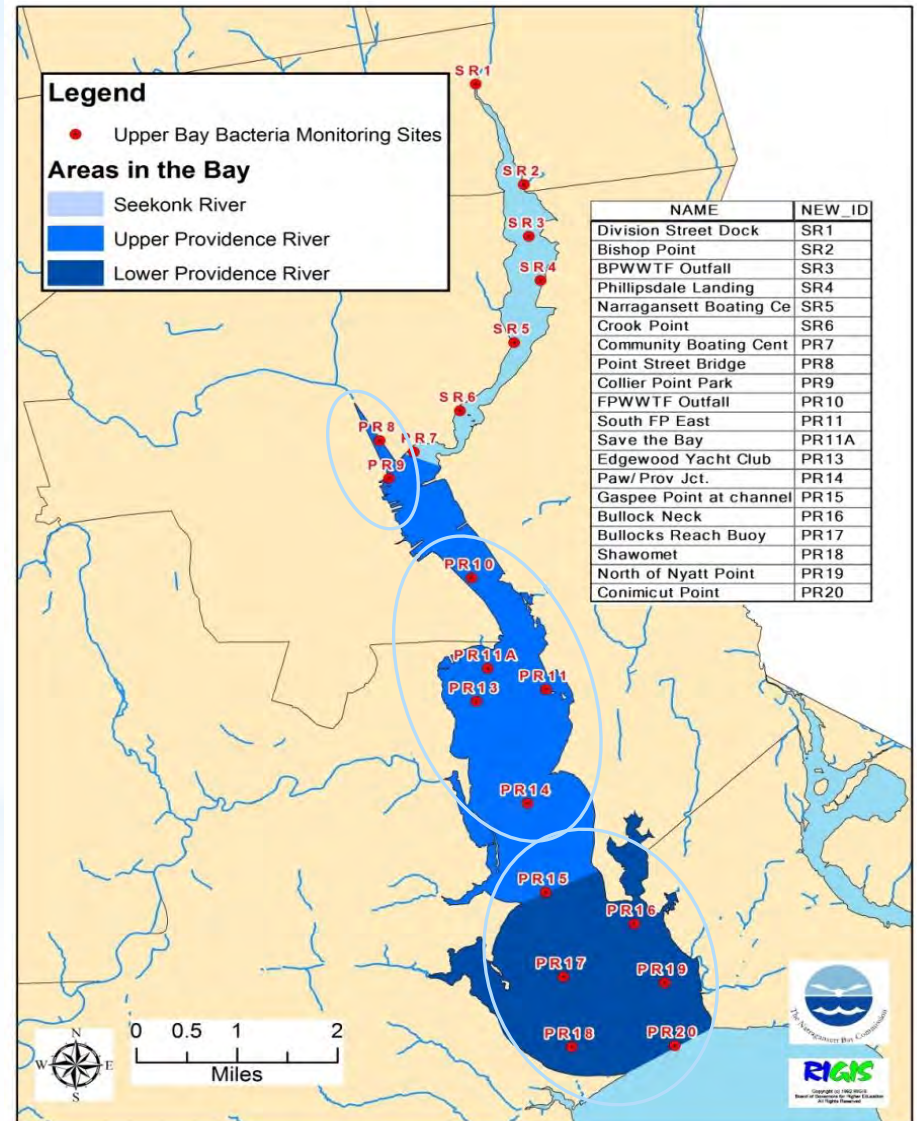


# Upper Bay Bacteria Data Analysis

## Meeting Water Quality Standards?

### Providence River Post Phase I

- Upper Providence River did not meet WQ Standards
- Mid Providence River:
  - ✓ Met more frequently after Phase I
  - ✓ 2014: ALL stations met for first time!
- Lower Providence River:
  - ✓ Met both criteria most years, improved post Phase I
  - ✓ 65% of years met pre Phase I
  - ✓ 87% of years met post Phase I



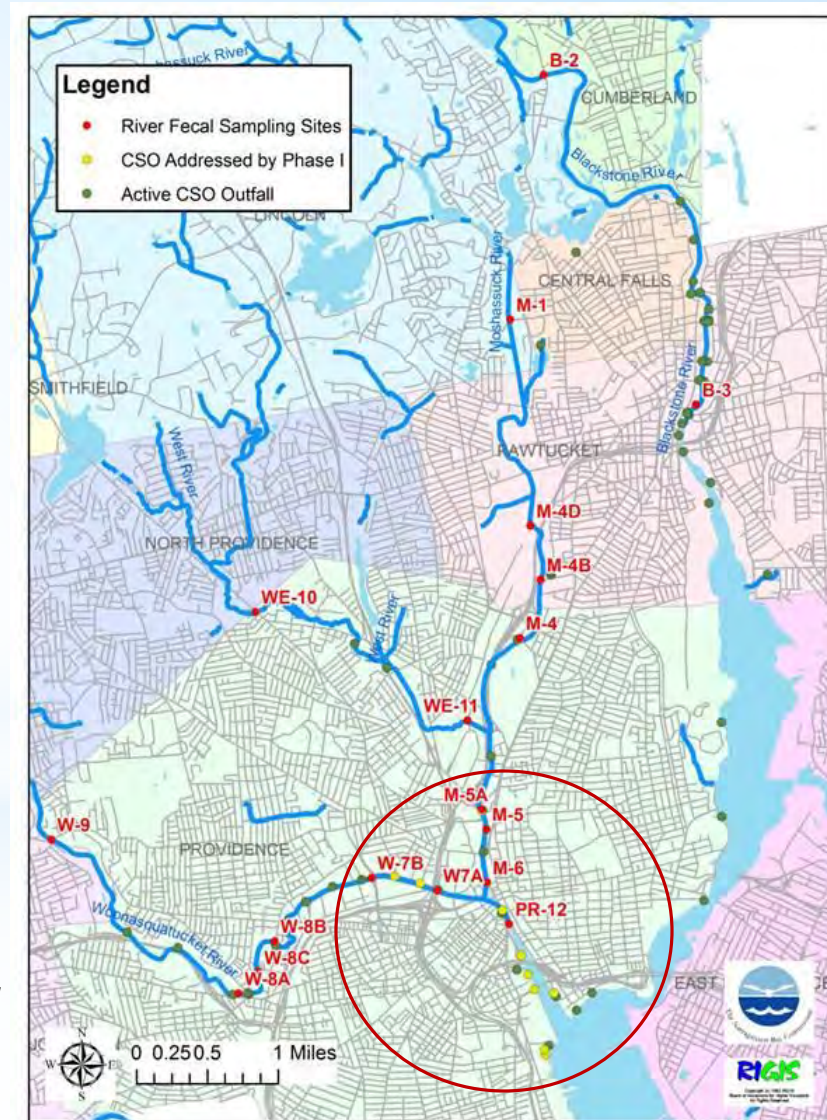
# Has Phase I Improved Upper Bay Shellfisheries?

- Regulations changed in 2011:
  - ✓ Cond. Area A closed with 0.8 inches of rainfall
  - ✓ Cond. Area B closed with 1.5 inches of rainfall
- RIDEM attributes closure changes to success of Phase I CSO Project
- 36% increase in number of acre-days Conditional Areas were open in 2013 compared to 2004 (Watershed Counts 2014)
- This is important because, in 2012....
  - ✓ 45% of the quahog harvest came from Areas A & B (54% in 2014!)
  - ✓ Totaling 17.5 million clams
  - ✓ Equaling \$2.48 million (Data from J. Mercer, RIDEM)
- DEM reevaluating the criteria now that Phase II is complete



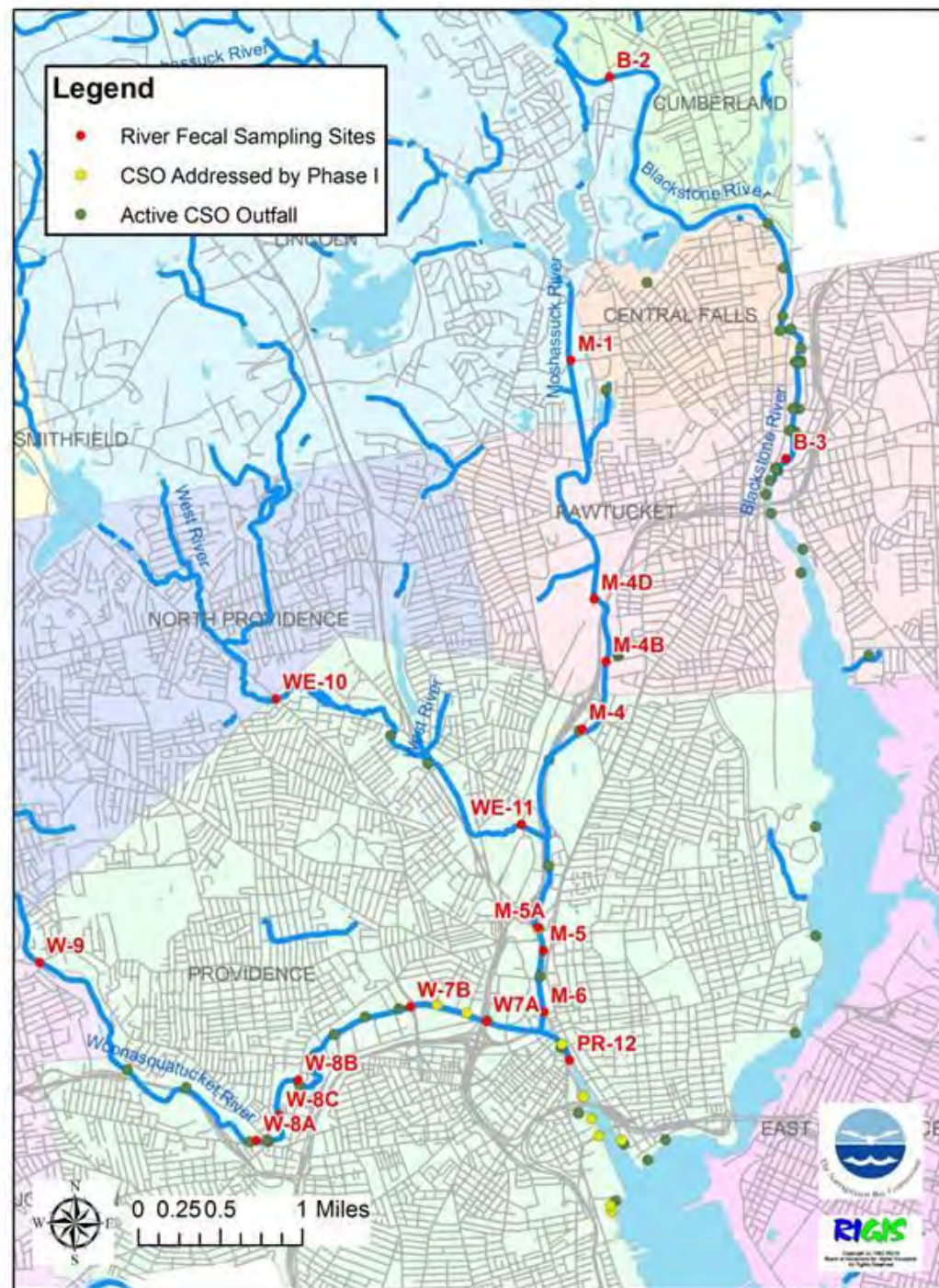
# Urban River Bacteria Sampling

- Required by DEM RIPDES Permits (CSO 9 Minimum Controls Program)
  - ✓ Data collected weekly Monday & Tuesday (Thursday if results elevated)
  - ✓ Monitor Up/Downstream of CSOs
  - ✓ 1 station on Pawtuxet River as baseline
- Includes data from 2004 – 2014
- Pre-Phase I (2004 – Oct 2008)
- Post-Phase I (Nov 2008 – 2014)
- Wet day – rainfall 3 days prior  $>0.1$  inches
- Dry day – rainfall 3 days prior  $<0.1$  inches
- Water Quality Determination
  - ✓ May – October
  - ✓ Geomean  $< 200$  MPN/100 mL
  - ✓ Not more than 10% samples  $> 400$  MPN/100 mL



# Urban River Bacteria Sampling

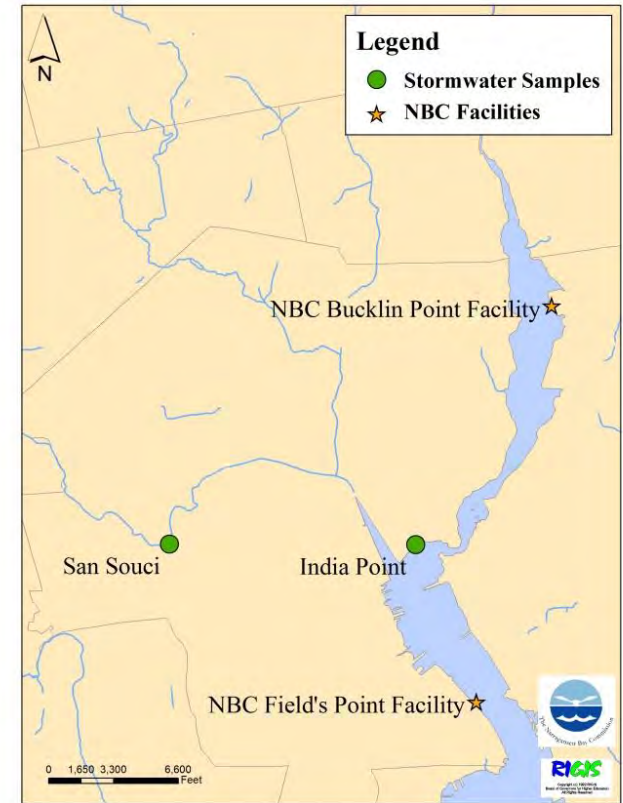
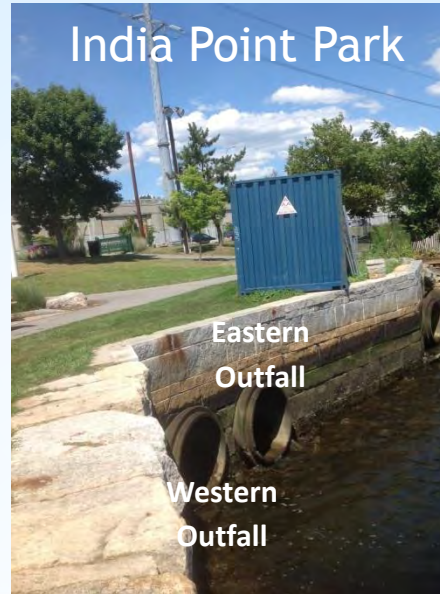
- Required by RIPDES Permits (CSO Nine Minimum Controls Program)
  - ✓ Data collected weekly Monday & Tuesday (Thursday if results elevated)
- Monitor upstream & downstream of CSOs
- Pawtuxet River station is baseline (No CSOs on river)
- Samples analyzed for fecal coliform, with some Enterococci analyses



# Stormwater Impairments

Average of Stormwater Samples

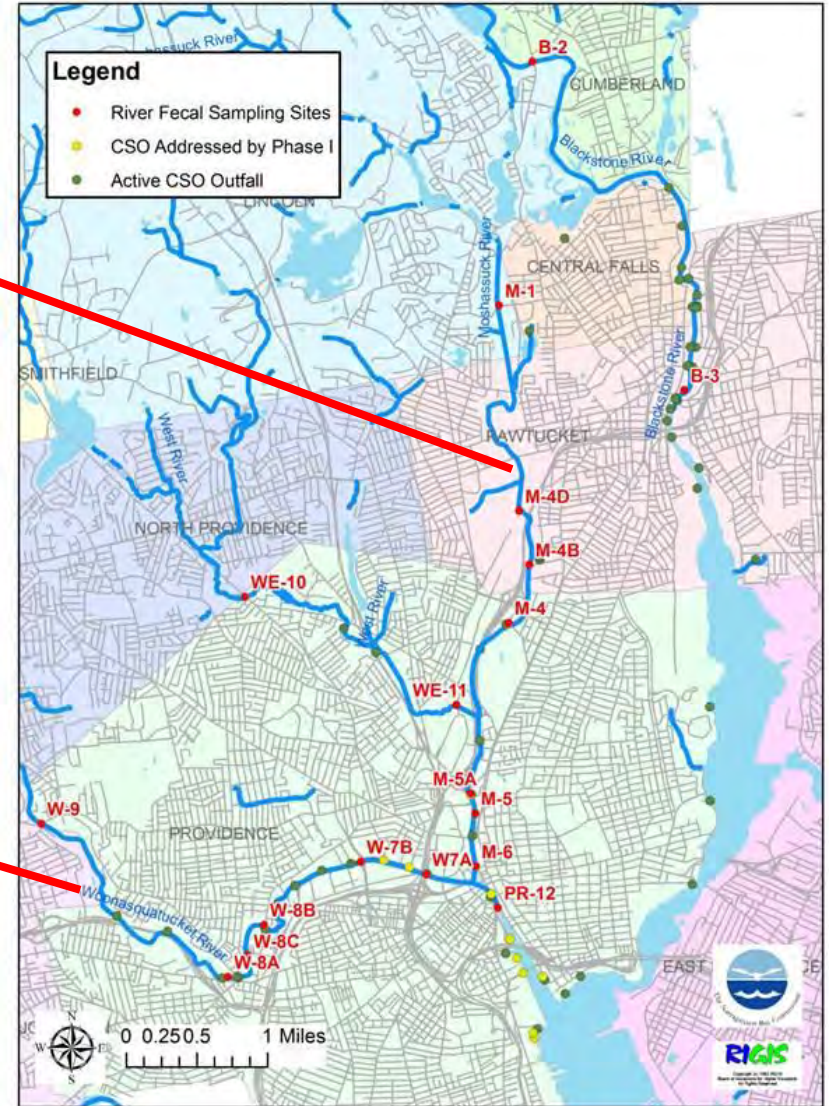
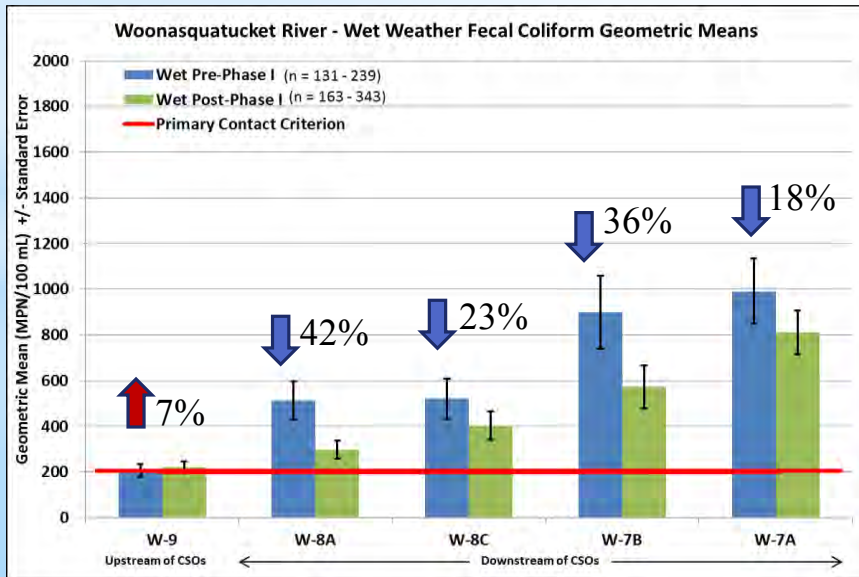
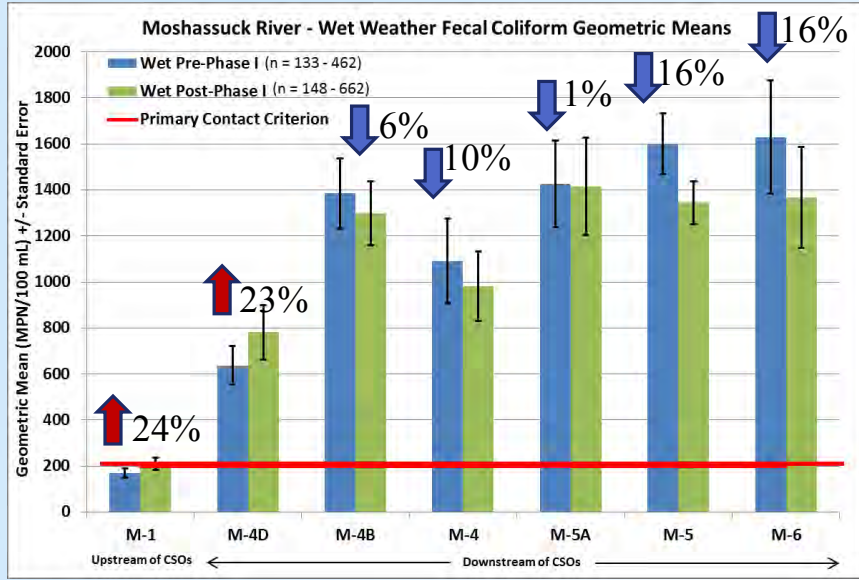
Constituent	Units	India Point	San Souci Dr.
Fecal Coliform	MPN/100 mL	>252,654	31,984
Enterococcus	MPN/100 mL	>2,420	>2,420
Total Suspended Solids	mg/L	124.00	83.33
Total Nitrogen	mg/L	3.70	<0.54
Total Kjeldahl Nitrogen	mg/L	2.49	<0.54
Nitrite + Nitrate	mg/L	1.21	<0.1
Ammonia	mg/L	1.39	<0.11
Dissolved Aluminum	µg/L	63.29	395.3
Dissolved Cadmium	µg/L	0.10	0.09
Dissolved Chromium	µg/L	3.01	3.05
Dissolved Copper	µg/L	55.67	8.68
Dissolved Iron	µg/L	182.95	505.17
Dissolved Lead	µg/L	31.66	43.07
Dissolved Nickel	µg/L	2.08	1.14
Dissolved Silver	µg/L	<0.02	<0.02
Dissolved Zinc	µg/L	116.93	53.02
Total Aluminum	µg/L	1,184	724
Total Arsenic	µg/L	1.54	<0.5
Total Cadmium	µg/L	0.27	<2.5
Total Chromium	µg/L	5.88	<10
Total Copper	µg/L	122.36	13.55
Total Iron	µg/L	1,828	1,188
Total Lead	µg/L	158.12	38.78
Total Nickel	µg/L	<10	<10
Total Zinc	µg/L	255.68	59.88



- Two stormwater outfall sampled
  - ✓ August 22, 2013 – 0.49 inches
  - ✓ September 30, 2015 – 2.02 inches (not first flush)
- Fecal coliform:
  - ✓ Range: 9,300 to > 24,000,000 MPN/100 mL
  - ✓ Exceeded primary contact criteria
- All *Enterococci* samples: >2,420 MPN/100 mL

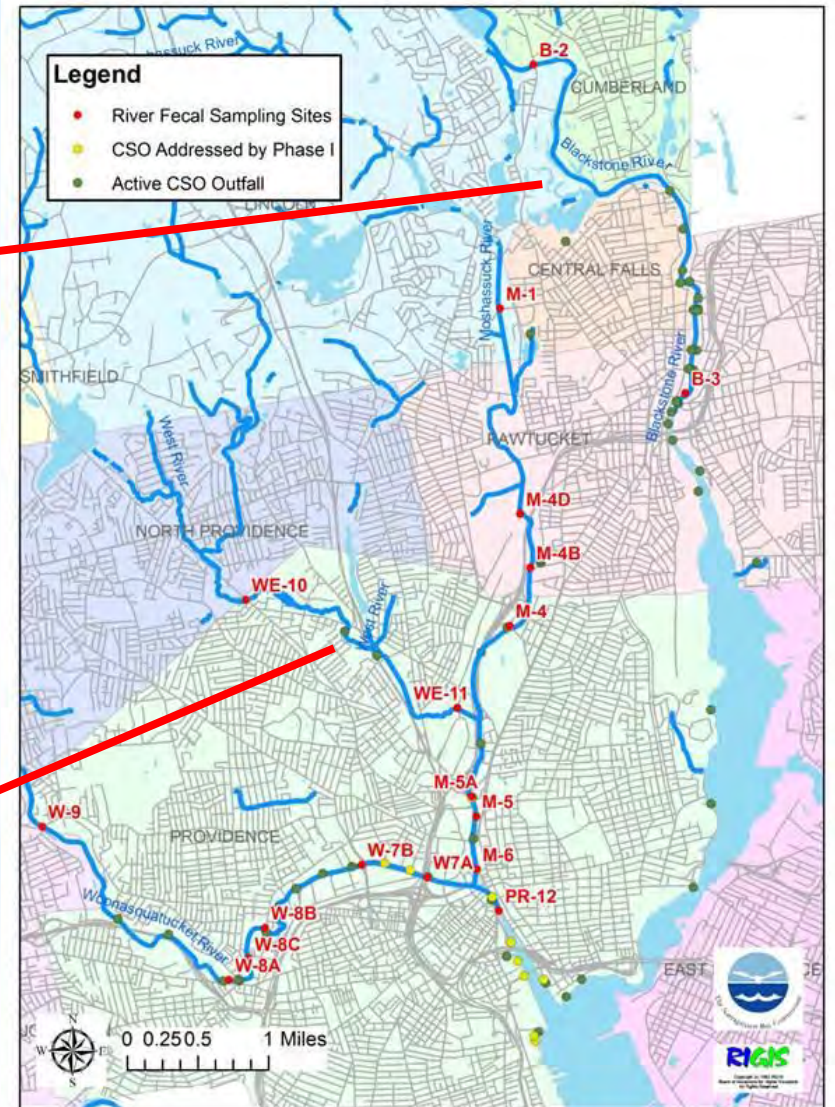
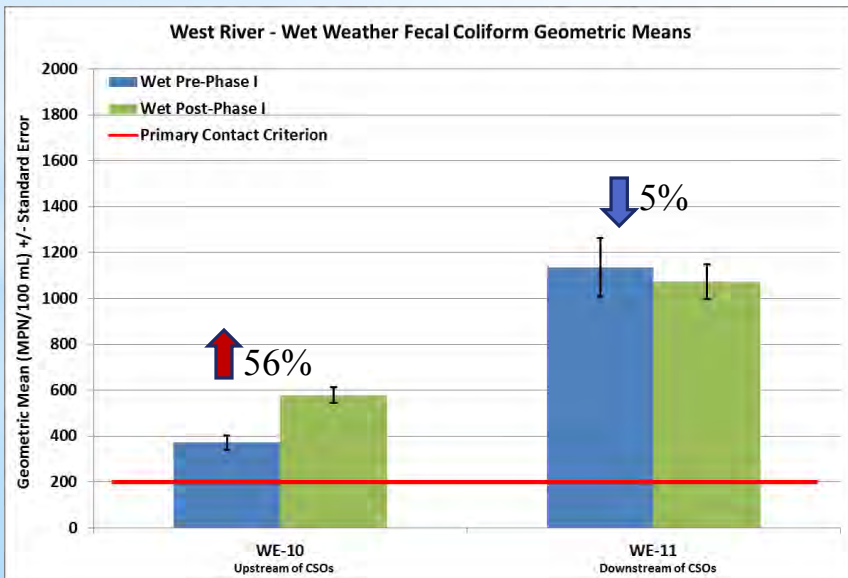
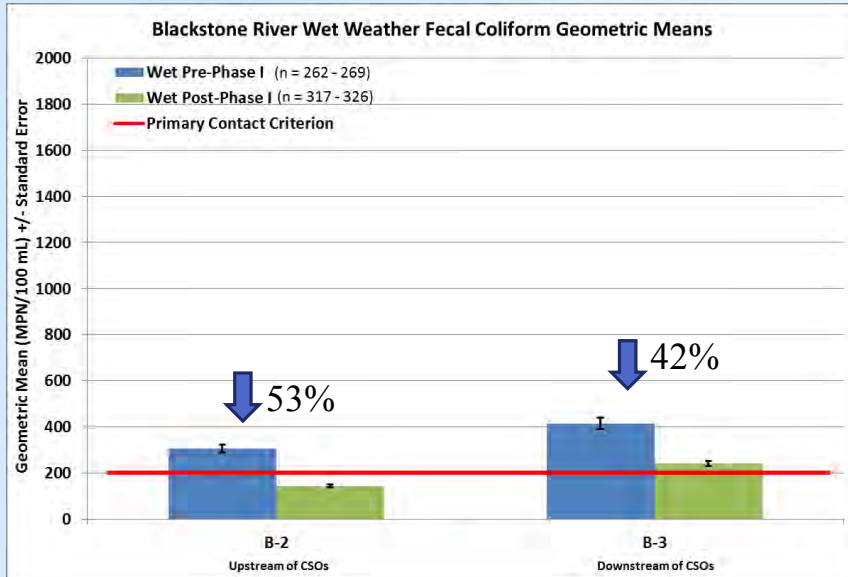
# Urban River Bacteria Data Analysis

## Wet Weather Results Pre vs Post Phase I Tunnel



# Urban River Bacteria Data Analysis

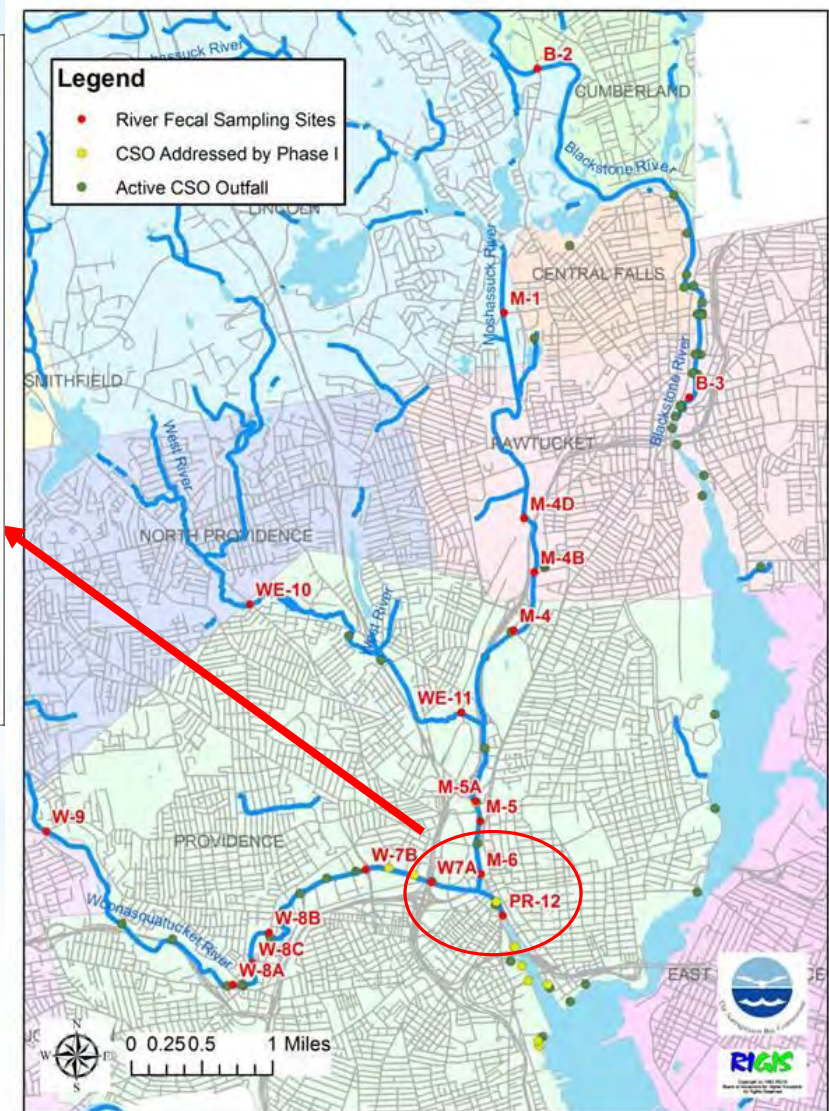
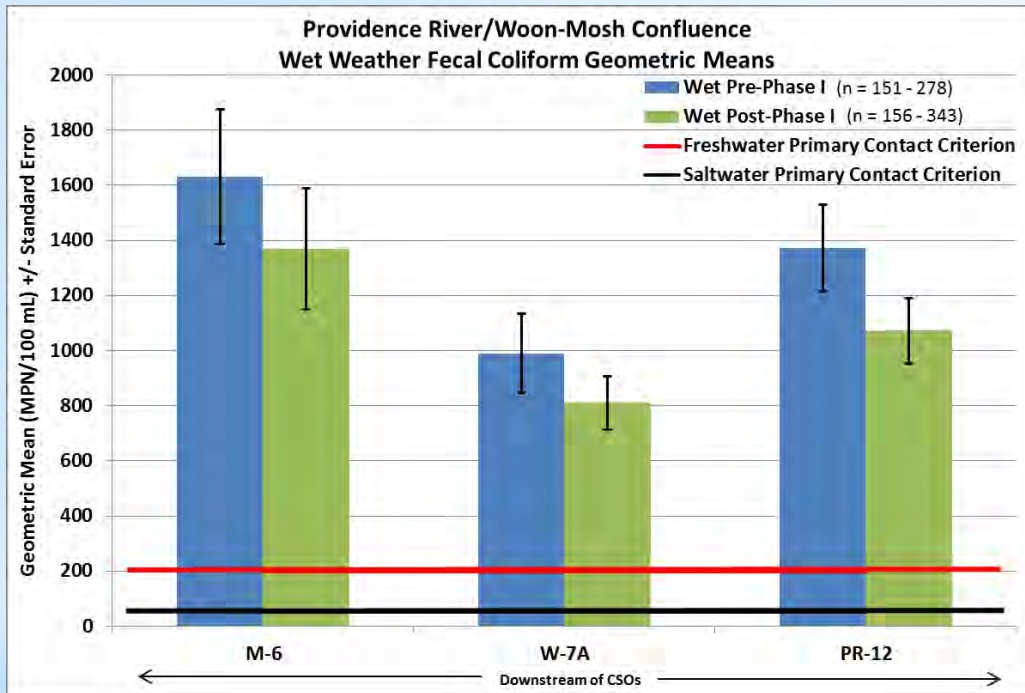
## Wet Weather Results Pre vs Post Phase I Tunnel





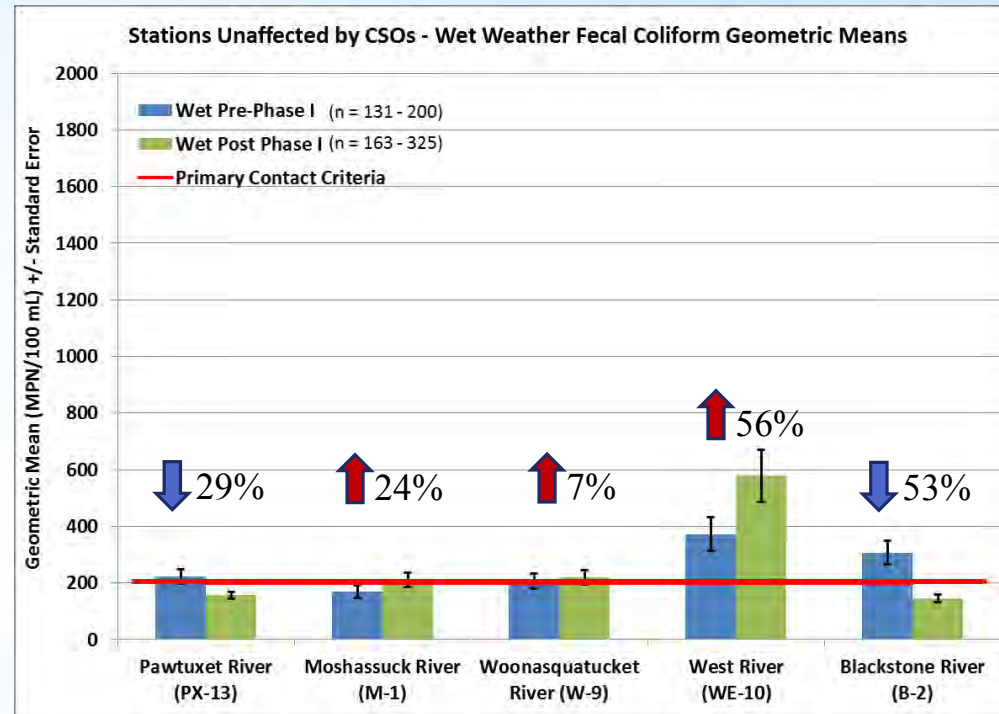
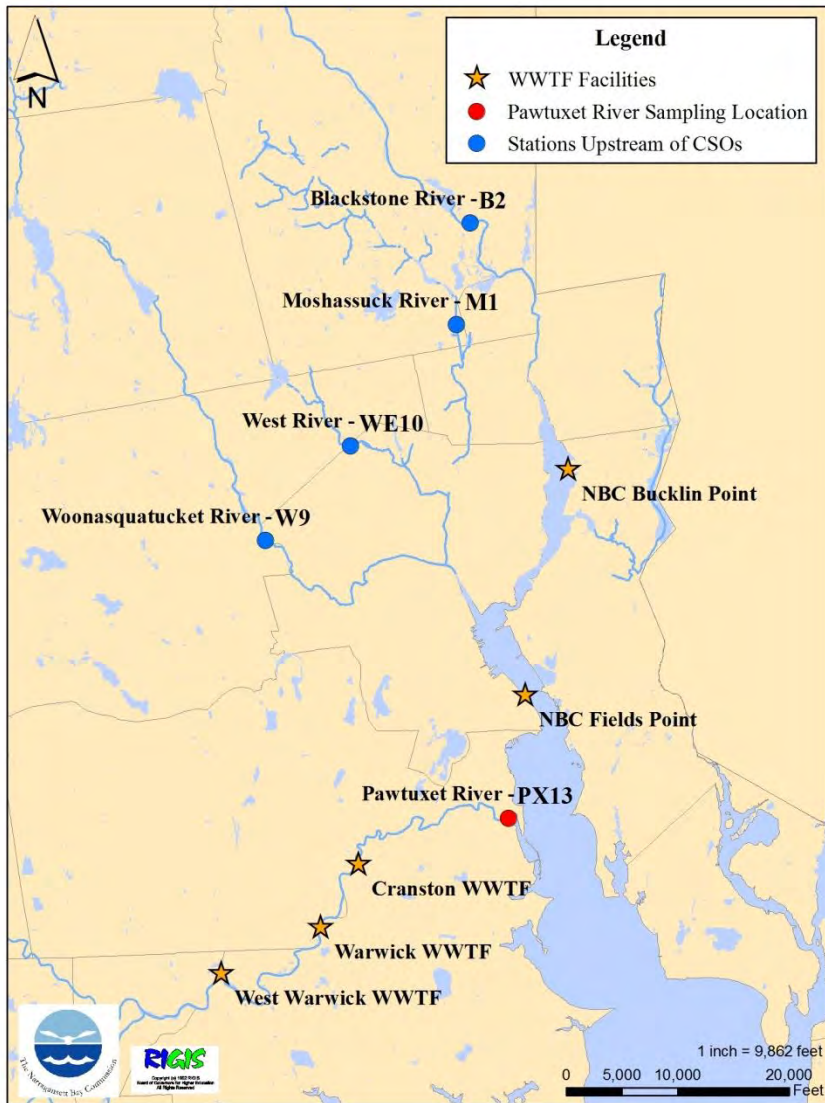
# Urban River Bacteria Data Analysis

## Wet Weather Results Pre vs Post Phase I Tunnel



- Moshassuck River mouth ↓ 16%
- Woonasquatucket River mouth ↓ 18%
- Providence River headwaters ↓ 22%

# Monitoring Stations Upstream of NBC CSOs



- NBC monitors stations upstream of CSOs
- Also samples Pawtuxet River (no CSOs on this river)
- **NBC Data shows frequent water quality violations at all stations**

# Urban River Bacteria Data Analysis

## Meeting Water Quality Standards?

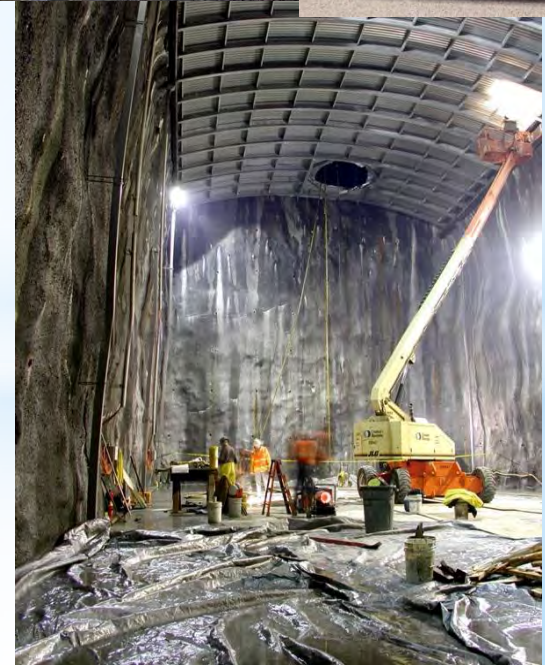
- **No stations met water quality criteria in all weather conditions (Wet and Dry)**
- Some stations met criteria using only dry weather results, but only in some years
  - ✓ Woonasquatucket River station met standards upstream of CSOs in 2008 & 2014
  - ✓ Blackstone River station met upstream of CSOs in all years but 2004, 2011 & 2012
  - ✓ Blackstone River station met downstream of CSOs in 2012 & 2014
  - ✓ Pawtuxet River station met in 2008 & 2009
- **Stations unaffected by CSOs are not always meeting criteria...other pollution sources upstream of CSOs need to be addressed**



# Phase I Summary

## Phase I CSO Tunnel Project has:

- ✓ Captured ~1.1 Billion Gallons/Year of CSO flow
- ✓ Reduced CSO volume and bacteria loads by ~50%
- ✓ Prevented millions of pounds of pollutants from discharging to our rivers and Narragansett Bay
- ✓ Assisted in reducing beach closures
- ✓ Allowed DEM to relax Shellfishing Closure standards
- NBC Received Water Environment Federation's National Water Quality Improvement Award
- But, monitoring stations unaffected by CSOs are not meeting standards
- **NBC CSO Abatement Program WILL NOT meet water quality standards:**
  - ✓ CSO System will still overflow ~ 4 times per year
  - ✓ Other Sources of Bacterial Pollution Needs to be addressed



*NBC Assist DEM Investigating Fish  
Kills on Seekonk River*

# Fish Kills in Seekonk River

Fish Kills have been observed in the Seekonk River

- ✓ August 3, 2014
- ✓ May 25, 2015
- ✓ July 18, 2015
- ✓ *August ????? 2015????*

✓ Headlines: “Oxygen-starved menhaden dying in Seekonk River”

✓ *Well, wait a minute, not so fast!!!!*

## Oxygen-starved menhaden dying in Seekonk River



Dead fish on the shoreline of the Seekonk River in East Providence, part of the fish kill that has struck the Atlantic menhaden population recently. Photo courtesy of Save The Bay.

A10 Thursday, July 30, 2015

### ENVIRONMENT Hundreds of fish die in area rivers

DEM blames fish kill on low oxygen levels

By Tracee M. Herbaugh  
Journal Staff Writer

The Rhode Island Department of Environmental Management is watching a large fish kill throughout the Seekonk and Providence rivers caused by low oxygen levels in the water.

Initial reports showed that the fish kill began in the upper Seekonk River around July 17.

The area found fish near Pawtucket pier as a result of low-oxygen levels in the river.

“Thousands of fish are dying in the river near Pawtucket Park, and the entire river system is affected,” said Tom Kutcher, an ecologist and advocate with Save The Bay, a nonprofit organization that works to protect and improve the conditions of Narragansett Bay.

“Lots of pogies are doing what I call their death spiral,” Kutcher said. “Where they swim around in circles, close to the surface, and gasp for air like goldfish do.”

The Seekonk River is an upper part of the Narragansett Bay estuary, where saltwater mixes with freshwater. This particular population of menhaden migrates from locations in the mid-Atlantic to look for food and can end up in Narragansett Bay. In the last few years, however, the fish have been swimming farther up the river to feed on plankton.

A few environmental conditions have influenced the fish kill, Kutcher explained. Ultimately, though, the fish aren't getting enough oxygen in the water.

Tom Kutcher and advocate with Save The Bay, a nonprofit organization that works to protect and improve the conditions of Narragansett Bay, estimated “thousands” of fish have died off.

By Tracee M. Herbaugh  
Journal Staff Writer

Posted May, 29, 2015 at 11:15 PM

PAWTUCKET, R.I. — Hundreds of dead Atlantic menhaden have been washing up on the banks of the Seekonk River near the Pawtucket Falls, and many more are expected to perish in a die-off caused by various environmental circumstances.

About 2,000 of the silvery bait fish, often called pogies, have died or are almost dead, according to Tom Kutcher, an ecologist and advocate with Save The Bay, a nonprofit organization that works to protect and improve the conditions of Narragansett Bay.

“Lots of pogies are doing what I call their death spiral,” Kutcher said. “Where they swim around in circles, close to the surface, and gasp for air like goldfish do.”

The Seekonk River is an upper part of the Narragansett Bay estuary, where saltwater mixes with freshwater. This particular population of menhaden migrates from locations in the mid-Atlantic to look for food and can end up in Narragansett Bay. In the last few years, however, the fish have been swimming farther up the river to feed on plankton.

A few environmental conditions have influenced the fish kill, Kutcher explained. Ultimately, though, the fish aren't getting enough oxygen in the water.

have more work to do.”

— therbaugh@providencejournal.com  
(401) 277-7067  
On Twitter: @T\_Marie

# Fish Kills in Seekonk River

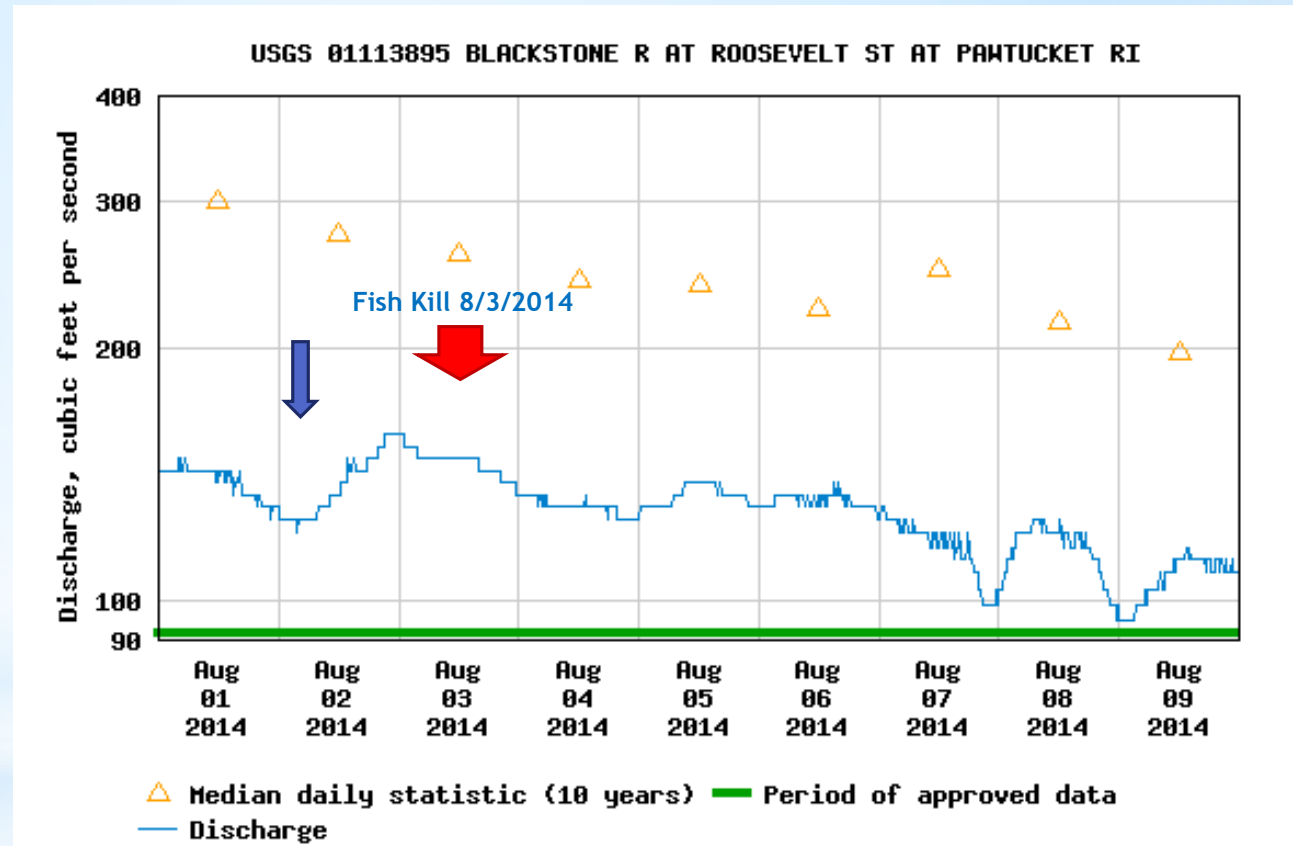
## NBC Observations:

- ✓ Hundreds of dead fish were observed floating and along the banks of the Seekonk
- ✓ Kill appeared to begin in the northern most portion of the Seekonk
- ✓ Only Menhaden seemed affected. Other schools of baitfish were observed.
- ✓ Very interesting things happening!!!



# Fish Kill in Seekonk River - 2014

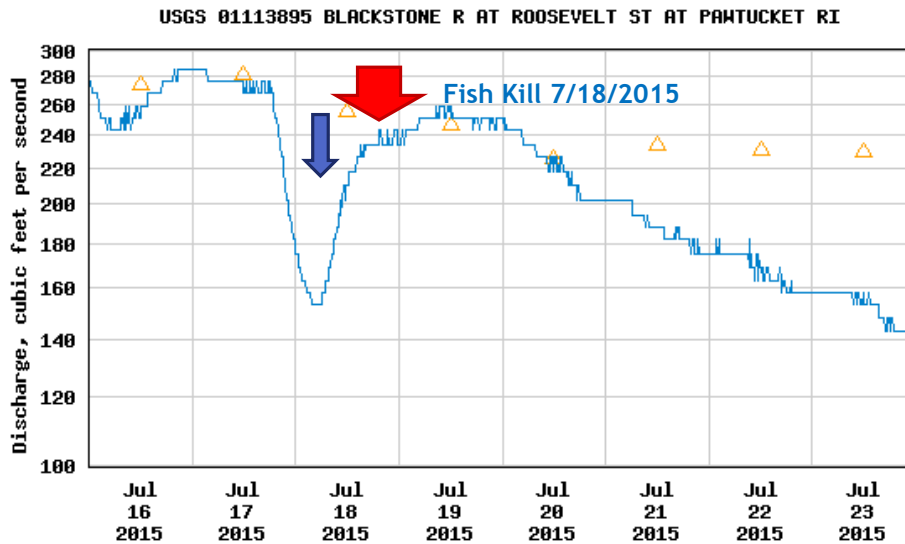
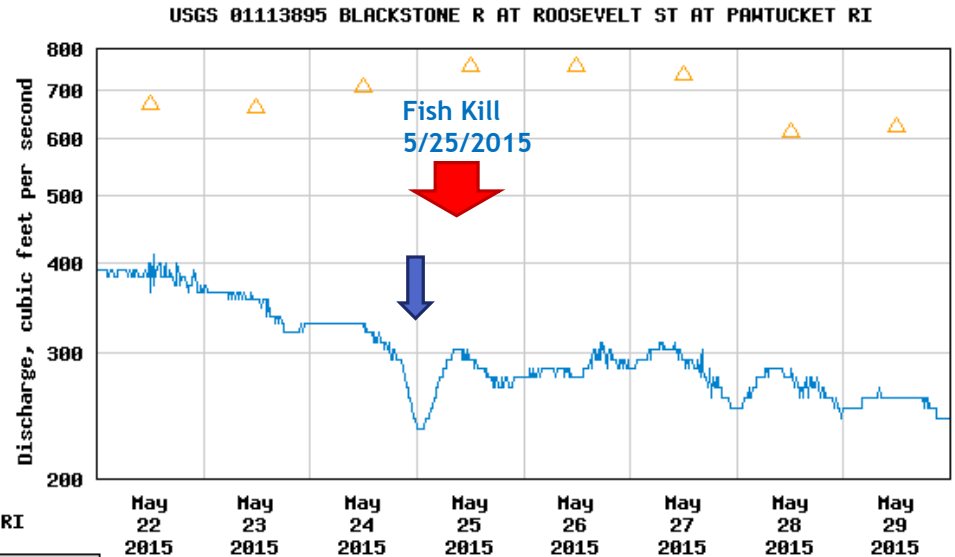
- ✓ Similarities in flow changes observed in Blackstone River for 2014 and 2015 fish kill events
- ✓ Significant flow drop observed a day or two before each event





# Fish Kills in Seekonk River - 2015

- ✓ Similarities in flow changes observed in Blackstone River for 2014 and 2015 fish kill events
- ✓ Significant flow drop observed a day or two before each event



△ Median daily statistic (10 years) — Discharge

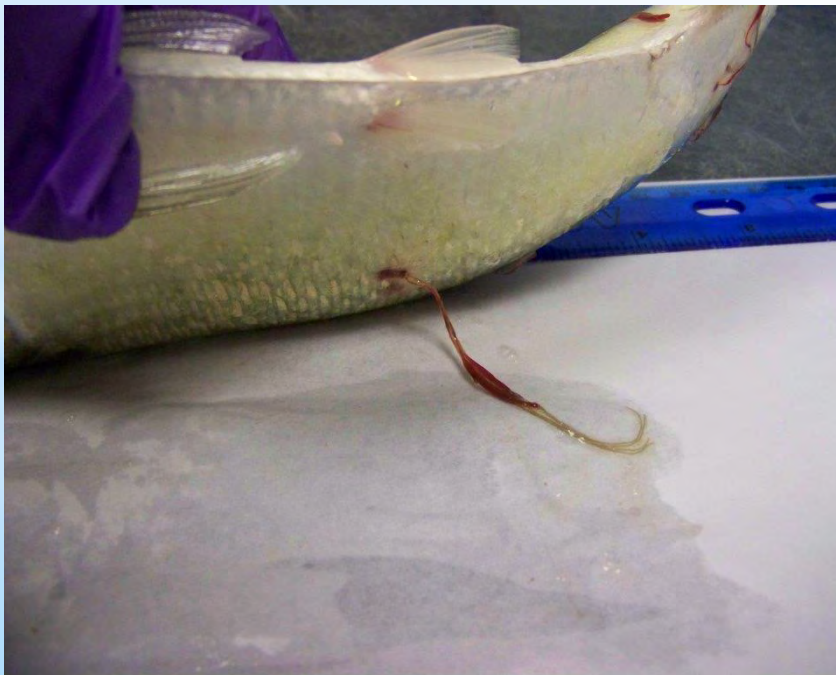
# Fish Kills in Seekonk River

- ✓ Atlantic Menhaden were observed doing the “Death Spiral”
- ✓ Menhaden seemed to be only fish affected
- ✓ Occurring in Atlantic Menhaden schools along the east coast
- ✓ Also occurring along CT coast and in CT rivers
- ✓ Viral “whirling” disease or the “death spiral” suspected by CT DEEP
- ✓ NBC collected 4 live Atlantic Menhaden for analysis by RWU



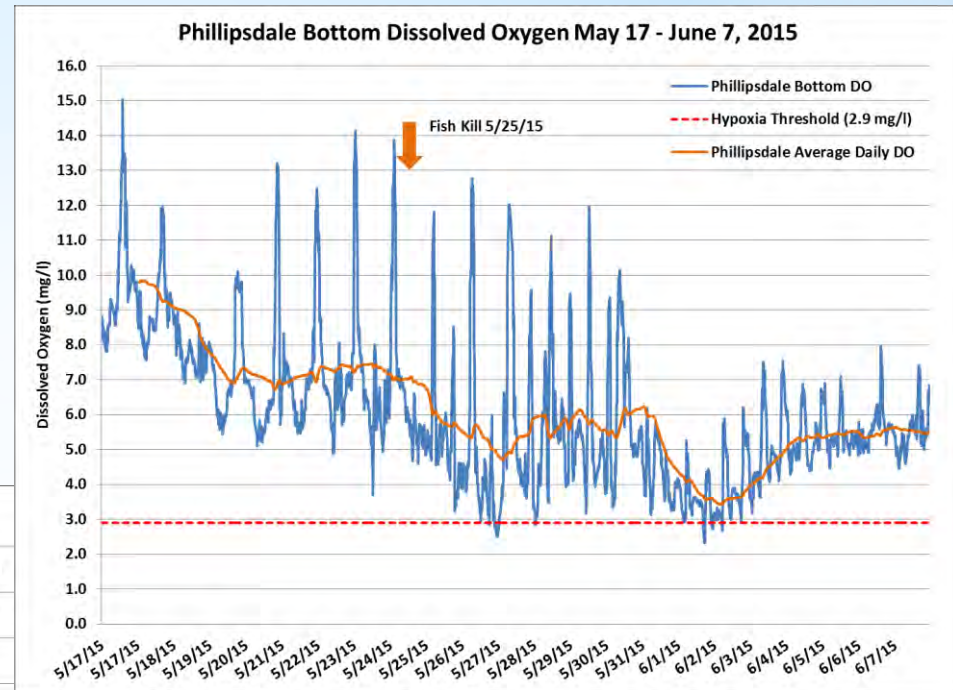
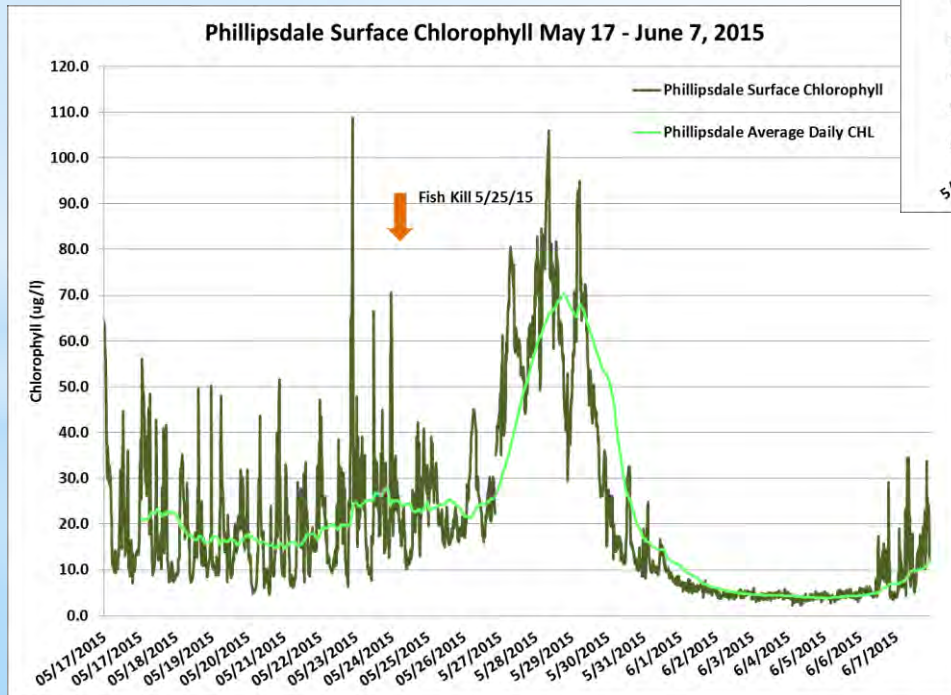
# Live Fish Samples Collected

- ✓ Fish collected by NBC were doing the “Death Spiral”
- ✓ One fish had anchor worm copepod parasites attached
- ✓ Fish were immediately frozen for transport to RWU for analysis



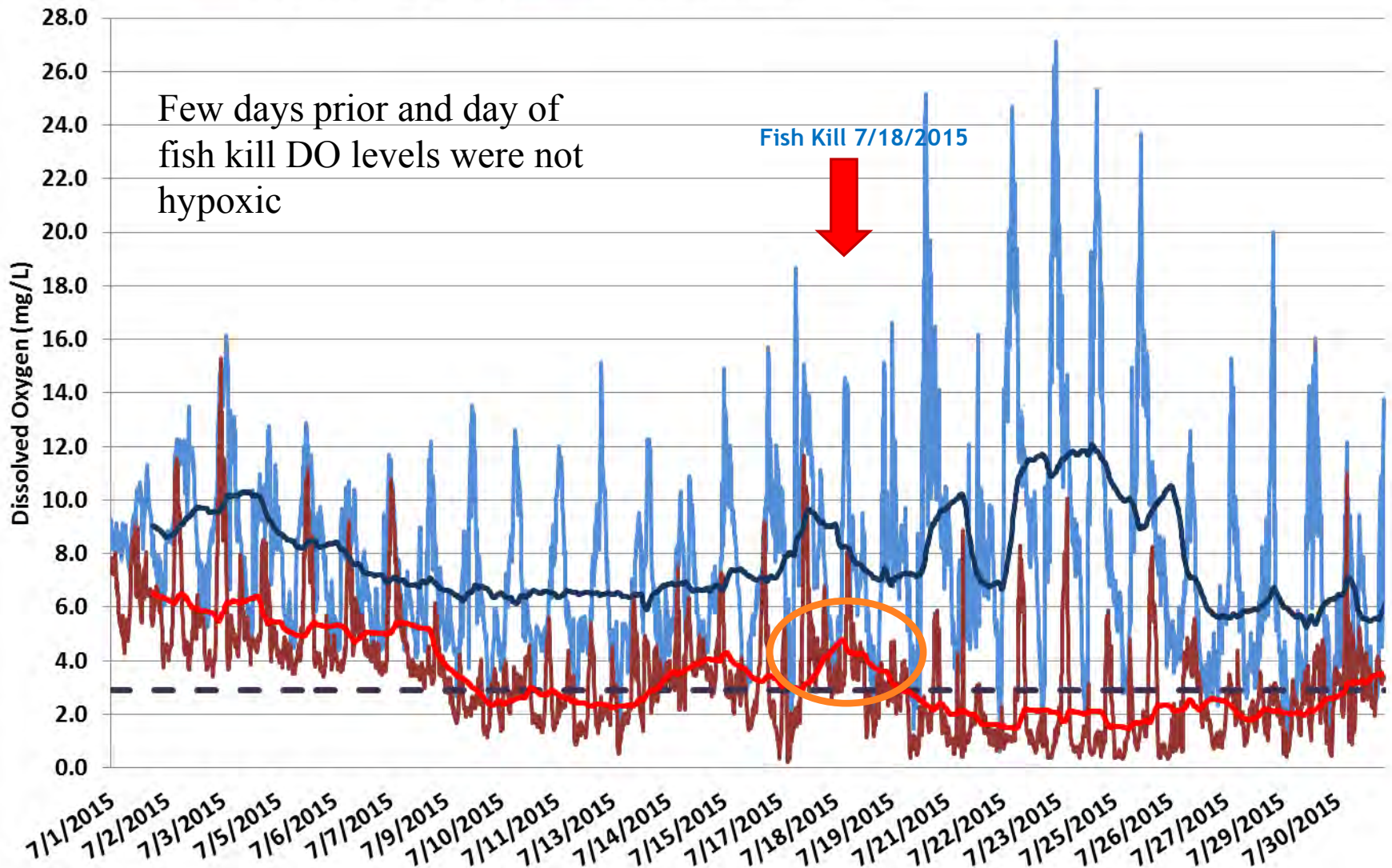
# Fish Kills in Seekonk River

- ✓ Bottom DO at Phillipsdale fixed site was not hypoxic for extended periods prior to the May 25<sup>th</sup> Fish Kill
- ✓ Chlorophyll Levels were high



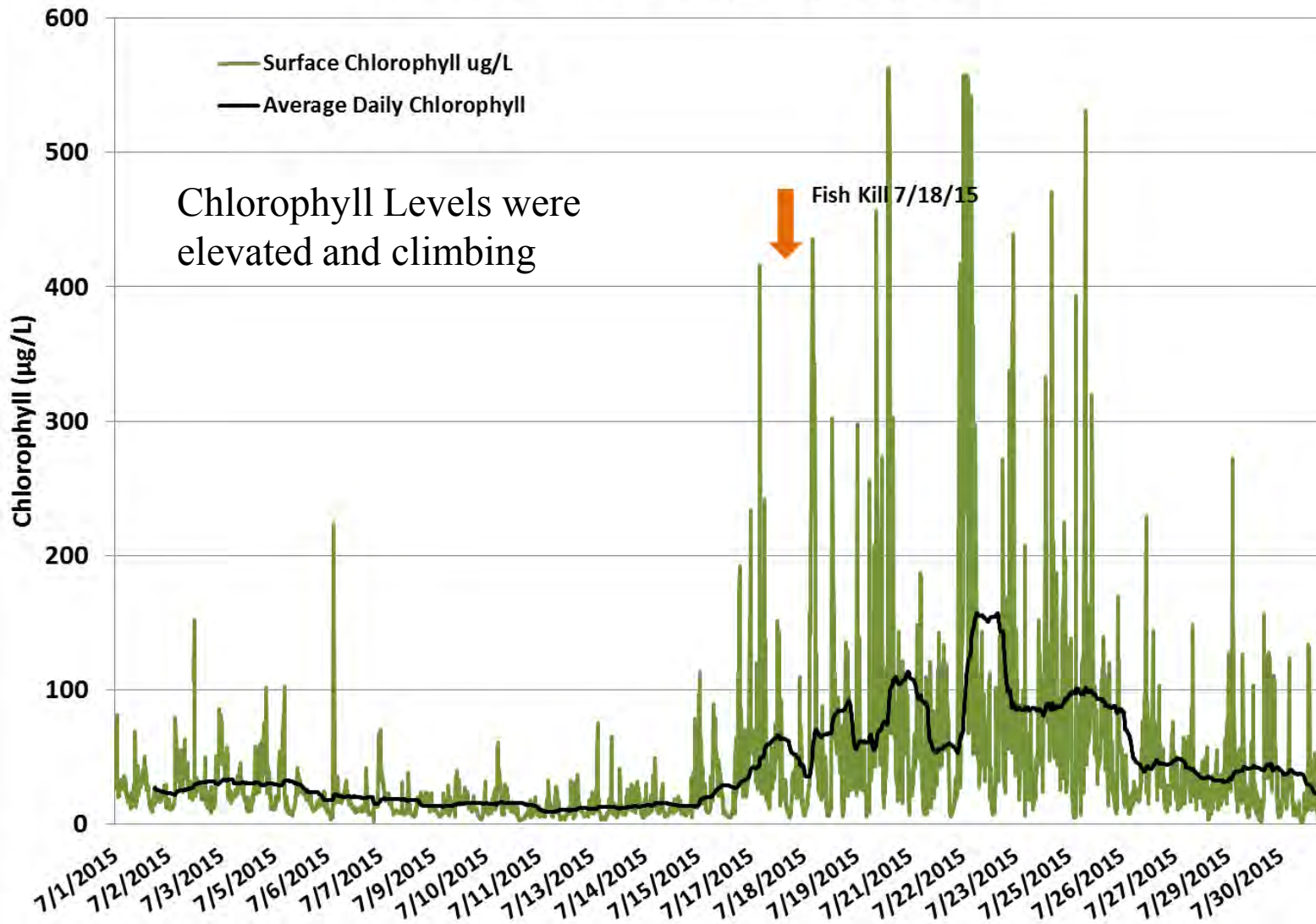
# Phillipsdale Surface and Bottom Dissolved Oxygen July 2015

— Surface DO mg/L      — Bottom DO mg/L      - - Hypoxia Threshold  
— Daily DO Average (Surface)      — Daily DO Average (Bottom)



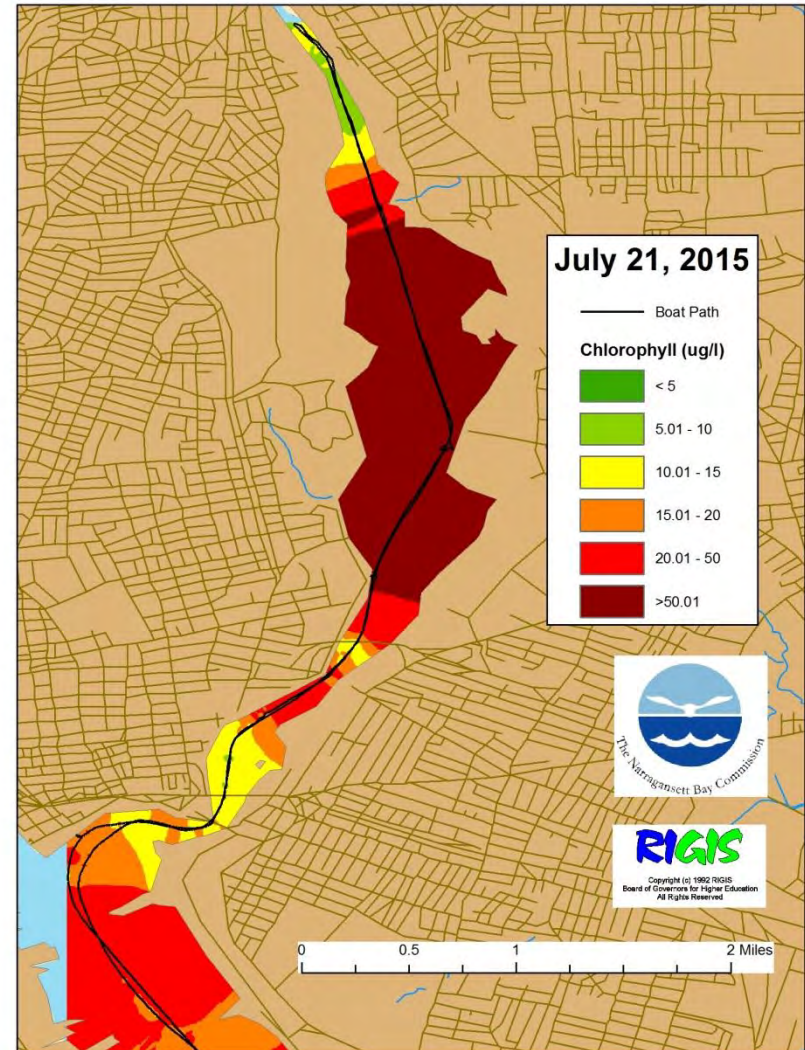
# Phillipsdale Surface Chlorophyll - July 2015

## Phillipsdale Surface Chlorophyll July 2015



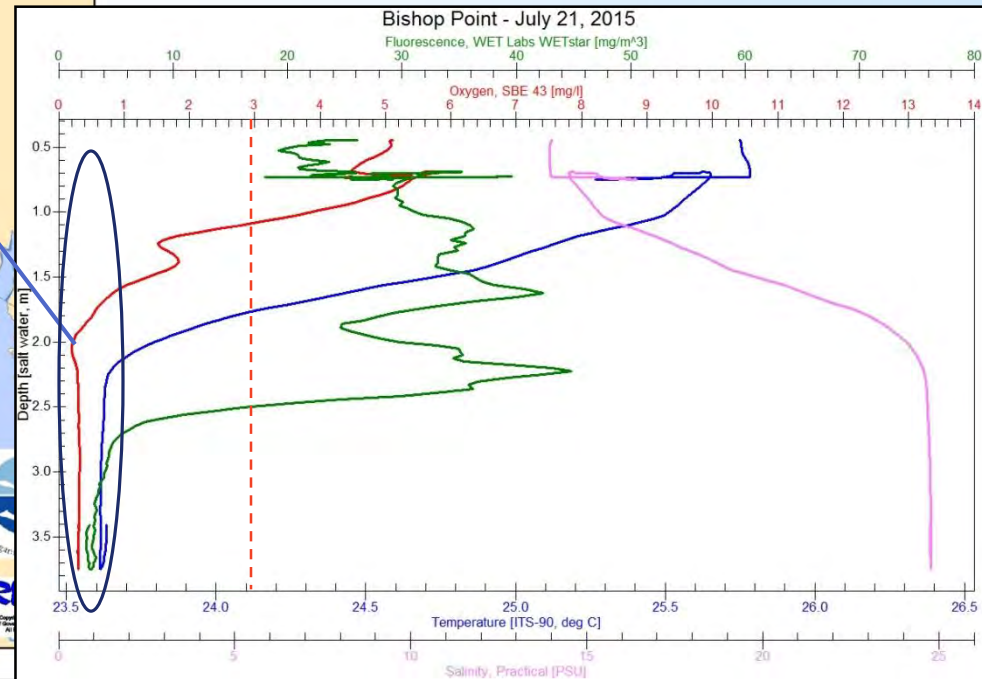
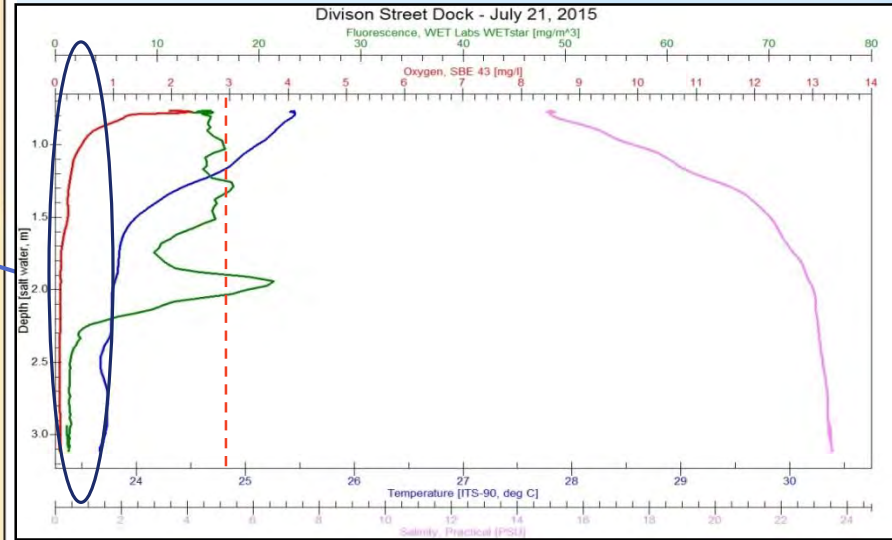
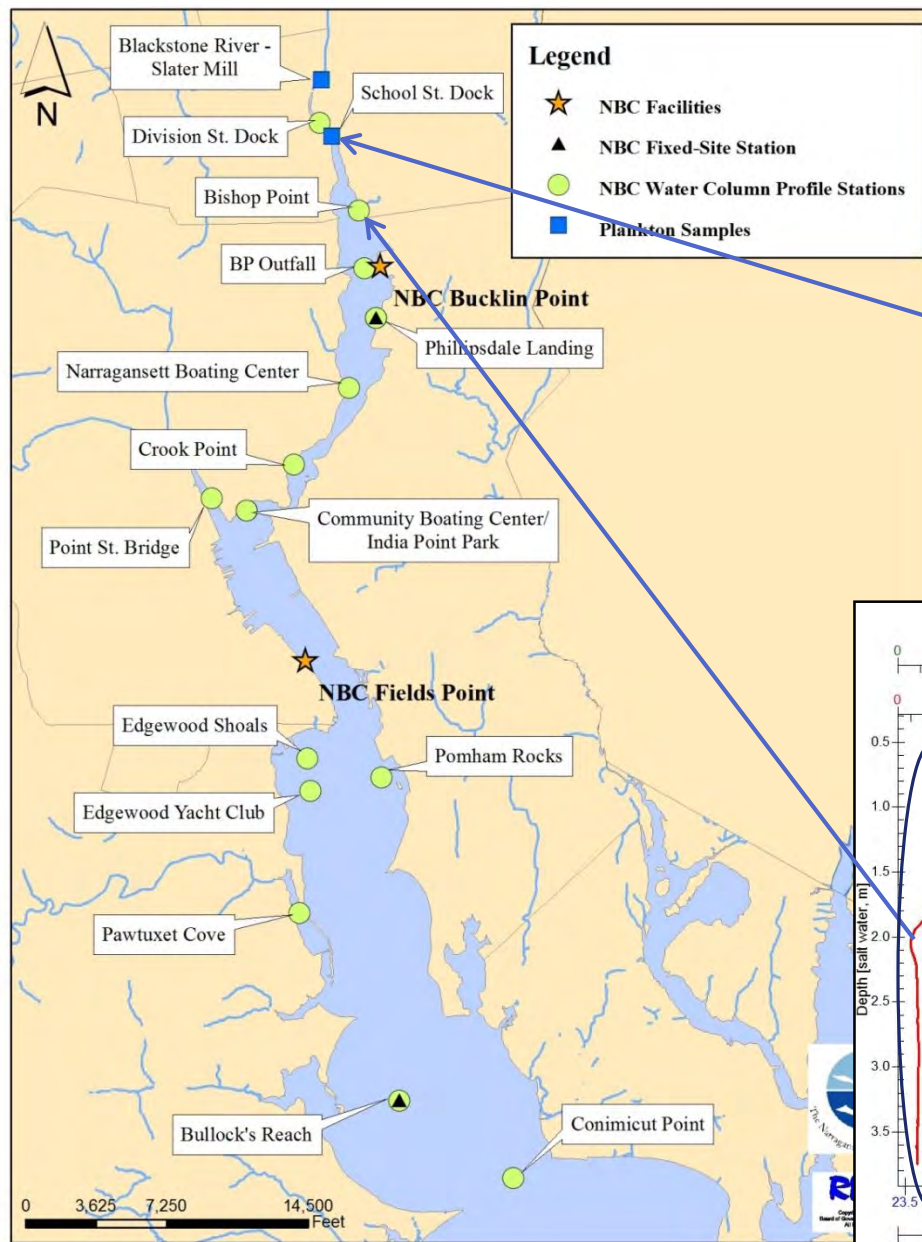
# Fish Kills in Seekonk River

- ✓ Surface Mapping was conducted 3 days after the fish kill
- ✓ Chlorophyll Levels were very high in the Seekonk
- ✓ Large Bloom was still occurring and moving downstream



# Seabird Data collected July 21 & 22, 2015

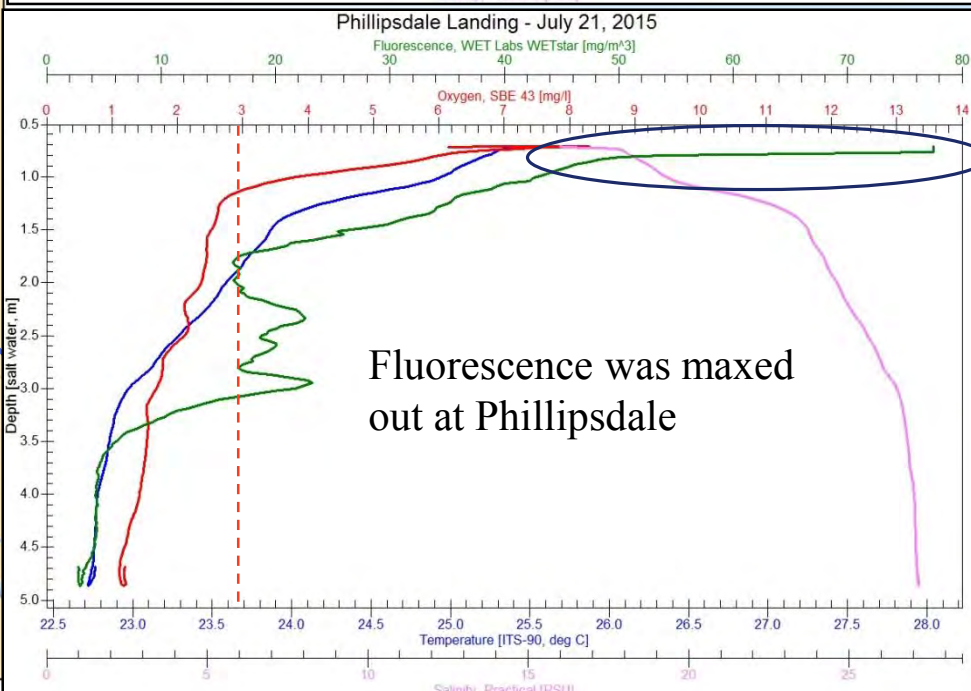
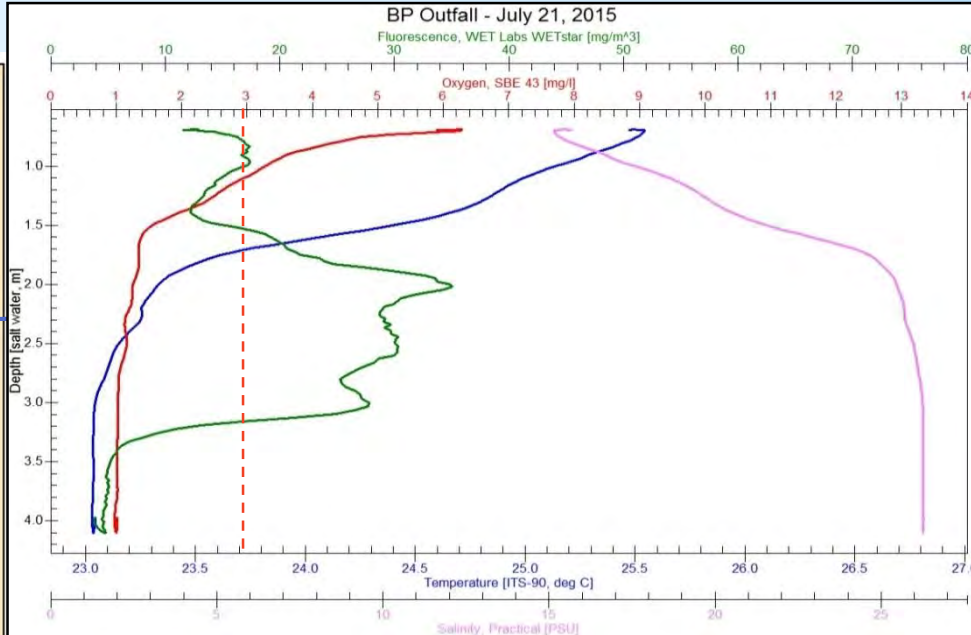
Water column profiles July 21, 2015  
 ✓ Division Dock & Bishop Point were both Anoxic





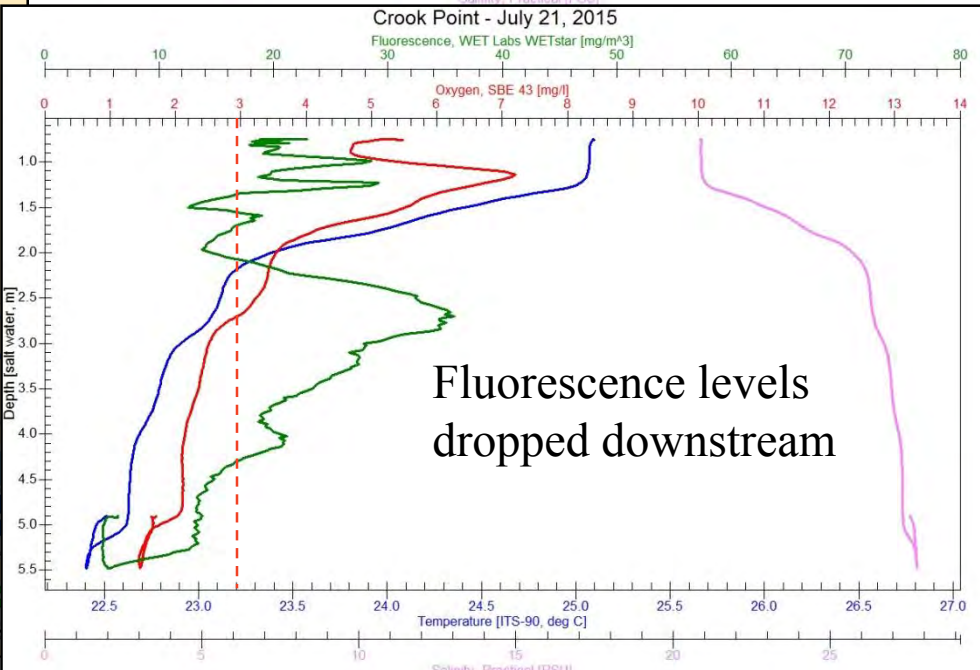
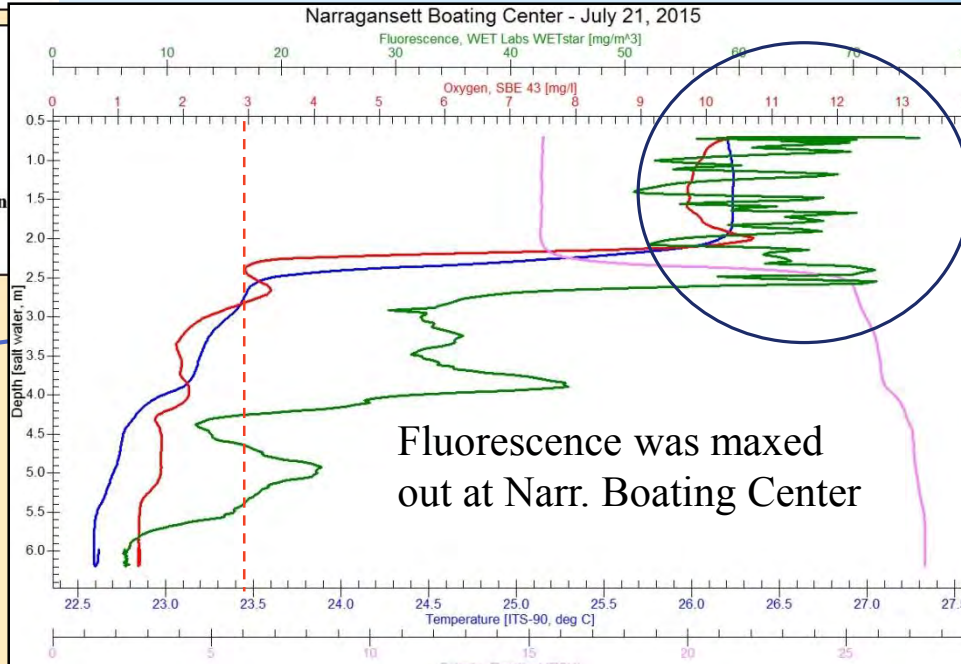
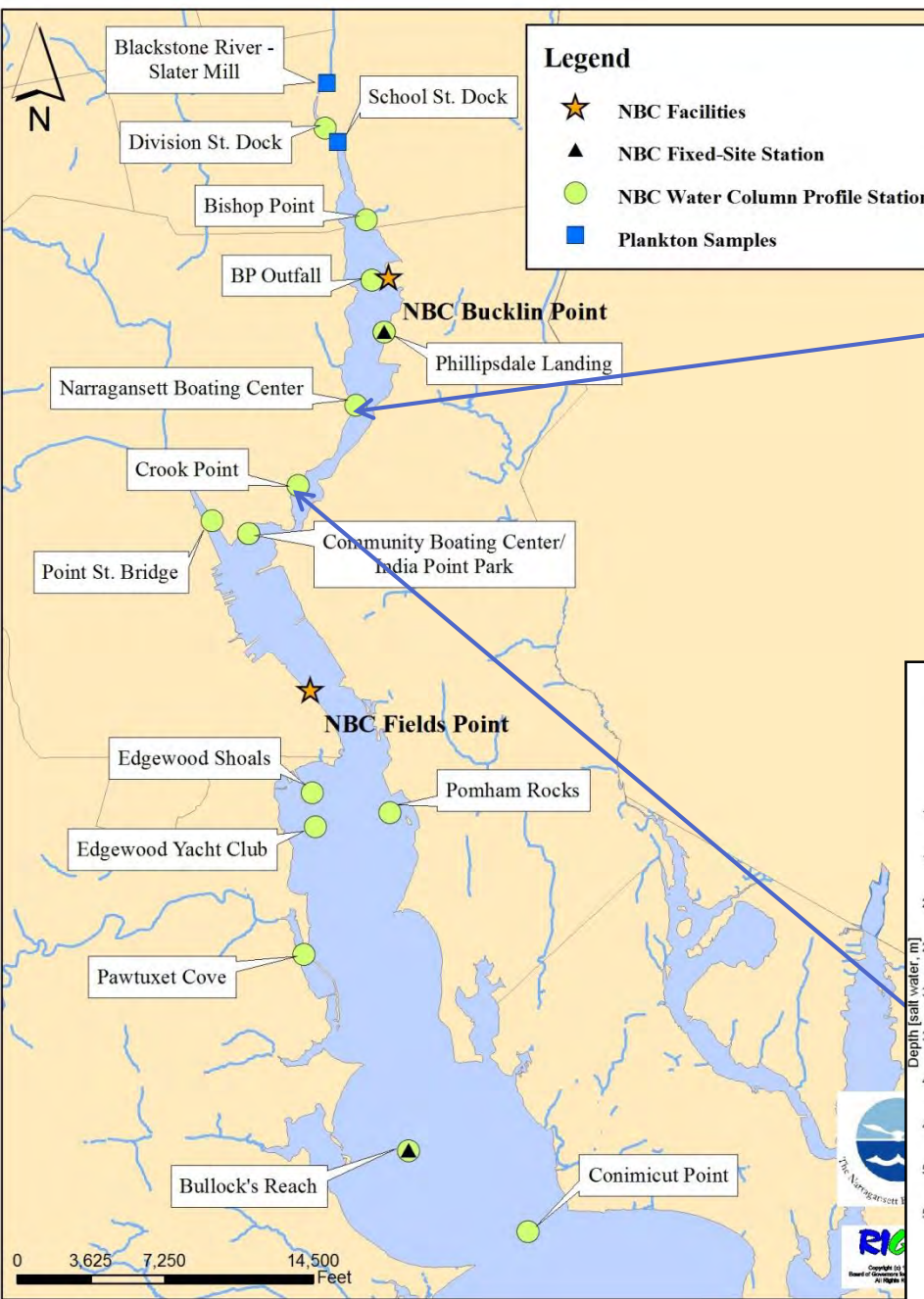
# Seabird Data collected July 21 & 22, 2015

# Water column profiles July 21, 2015



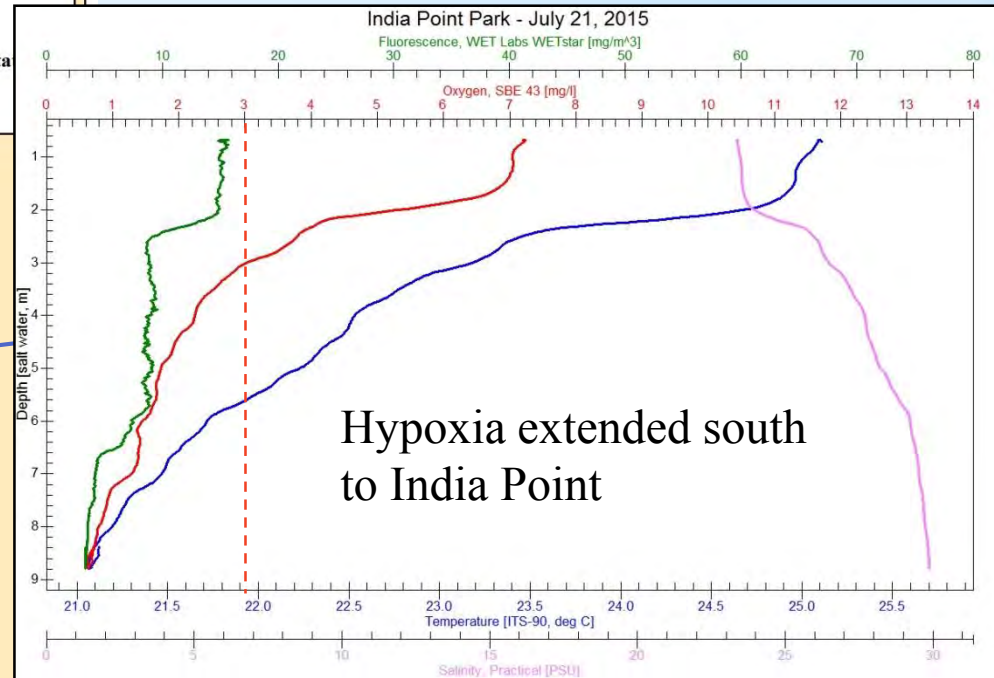
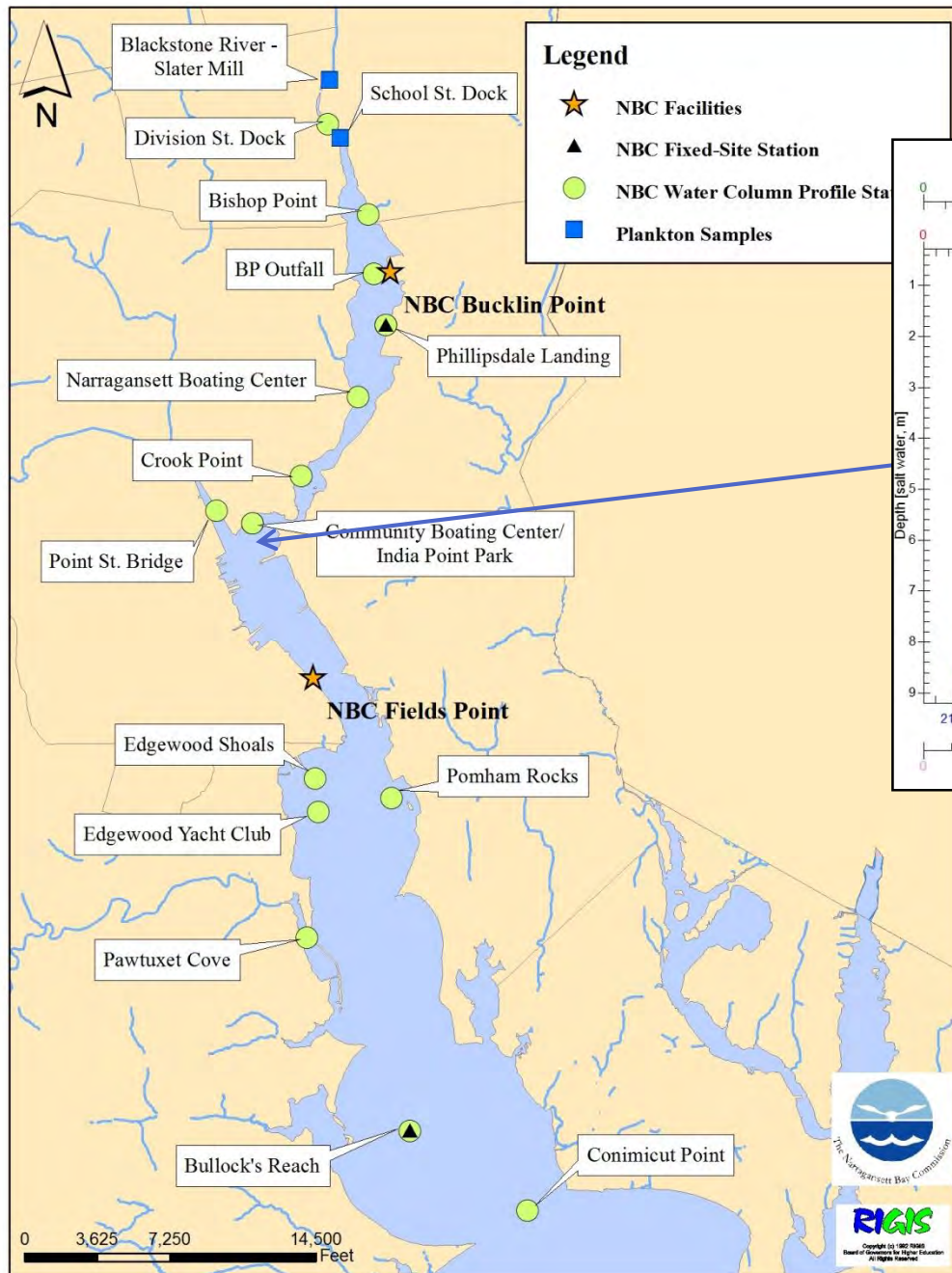
# Seabird Data collected July 21 & 22, 2015

# Water column profiles July 21, 2015



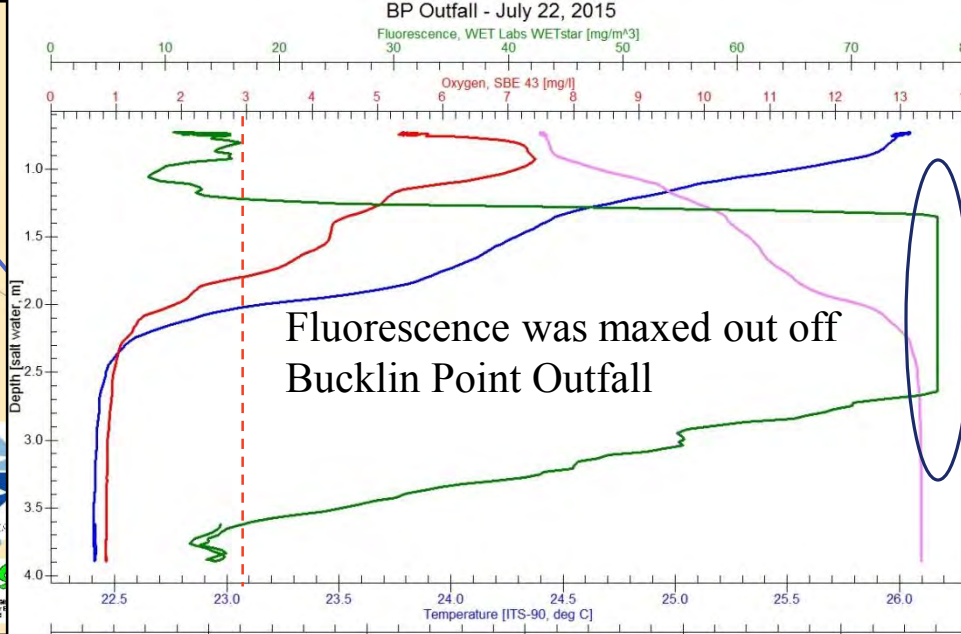
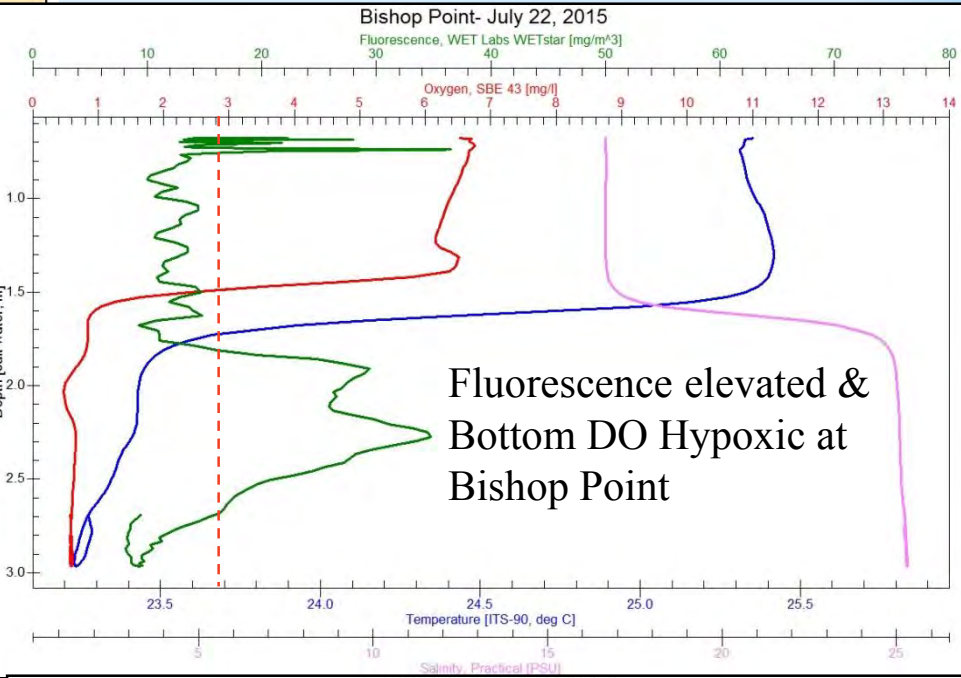
# Seabird Data collected July 21 & 22, 2015

## Water column profile July 21, 2015



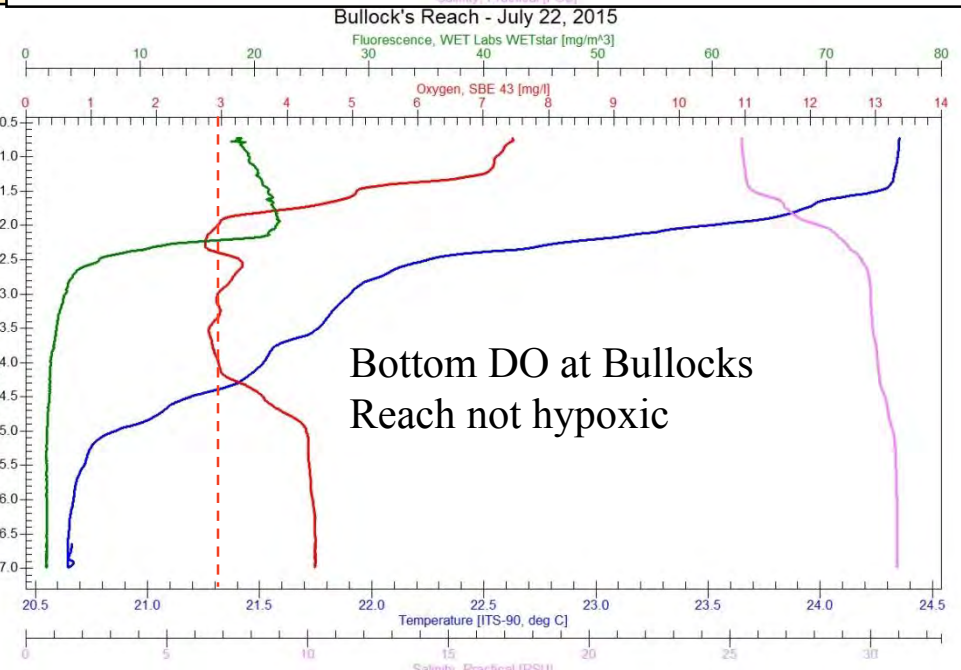
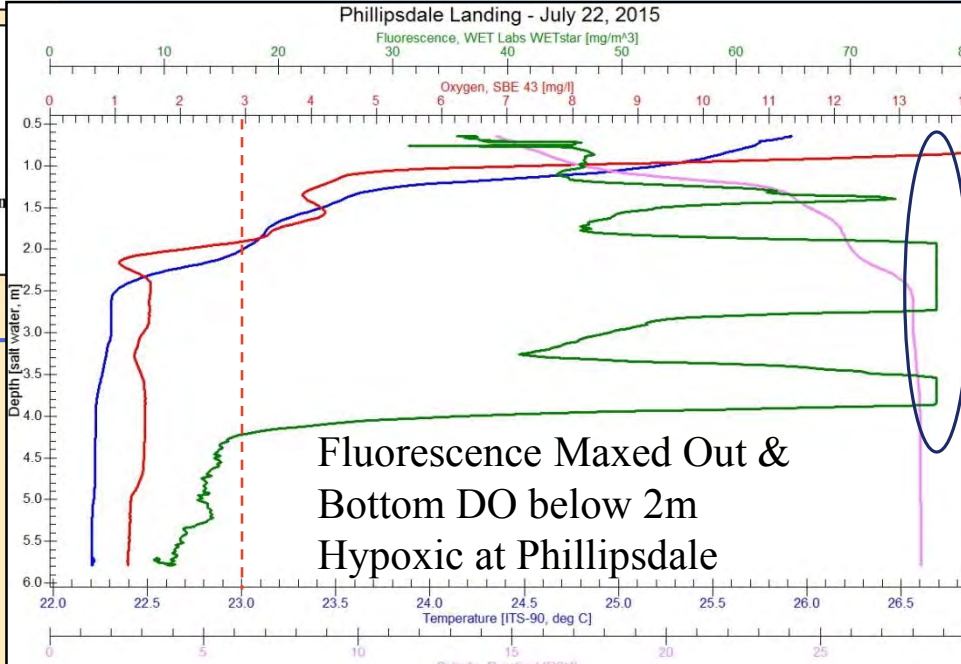
# Seabird Data collected July 21 & 22, 2015

# Water column profiles July 22, 2015



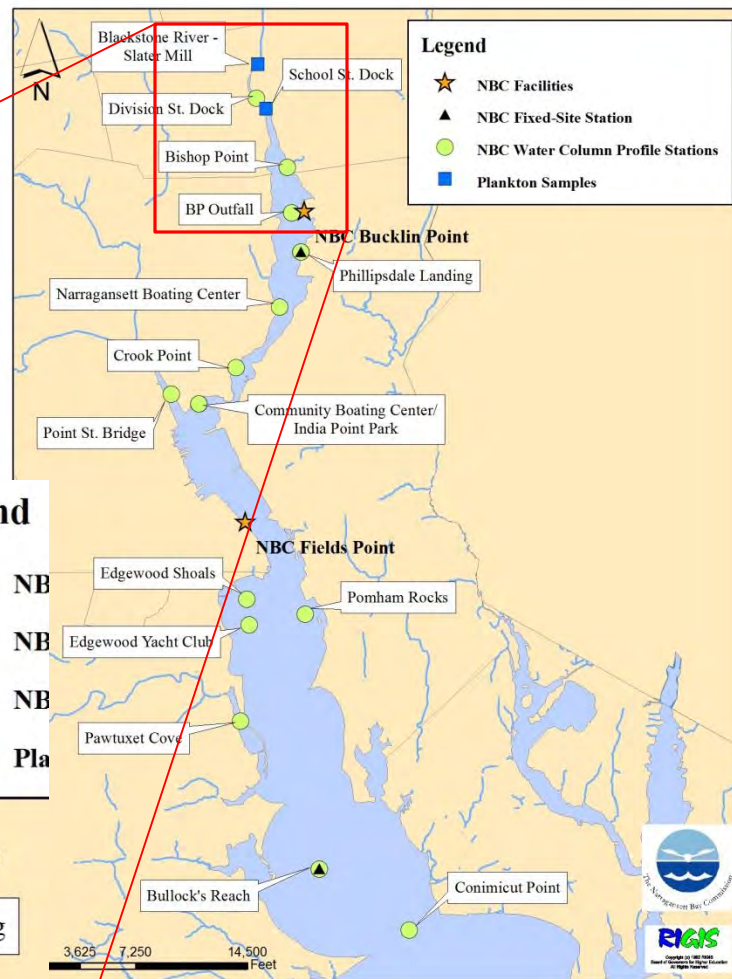
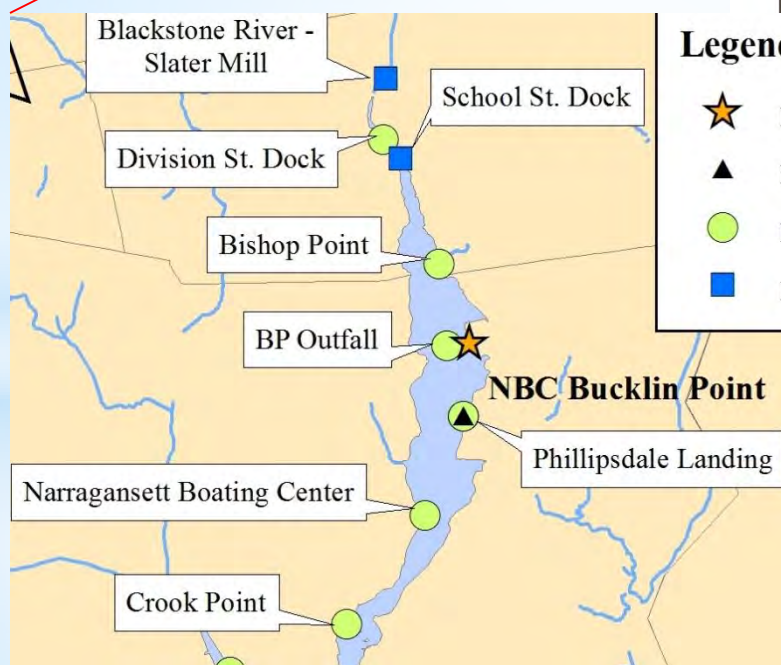
# Seabird Data collected July 21 & 22, 2015

# Water column profiles July 22, 2015




# NBC Collected Phytoplankton Samples

- ✓ Samples collected at **School Street Dock** – main location of fish kill and bloom
- ✓ Additional samples collected upstream of tidal influence on Blackstone River at **Slater Mill**



# NBC Performed Phytoplankton Analysis

- ✓ NBC performed phytoplankton sample collection & analysis
- ✓ Micrographs of observations recorded and shared with DEM and Dr. Tatiana Ryneason at URI-GSO

 **MICROBIOLOGICAL EXAMINATION**

July 23, 2015 Nora Lough Biologist

**Samples:** The following samples were submitted to the lab for microbiological examination

- Slater Mill sample 7-21-15 (tow net)
- School Street sample 7-21-15 (whole water)
- School Street sample 7-23-15 (tow net)
- School Street sample 7-23-15 (whole water)

**Observations:**

The plankton tow net sample was filterable with a 20 micron mesh. This concentrate was a light brown color with an easy filterability time. It was analyzed qualitatively for microorganisms using 100x phase contrast microscopy.

The whole water sample was analyzed quantitatively under 200x phase contrast microscopy. A Hensen Stempel pipette was used to accurately deliver 1ml of sample to a Sedge-wick Rafter chamber.

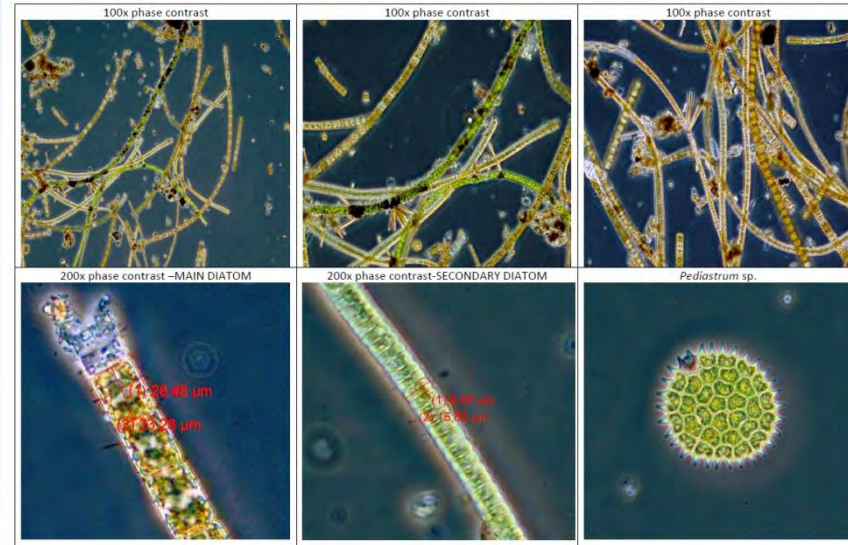
The whole water samples revealed the total number of phytoplankton:

- School Street sample 7-21-15 (whole water) Total number of phytoplankton=694,000/L
- School Street sample 7-23-15 (whole water) Total number of phytoplankton=582,000/L

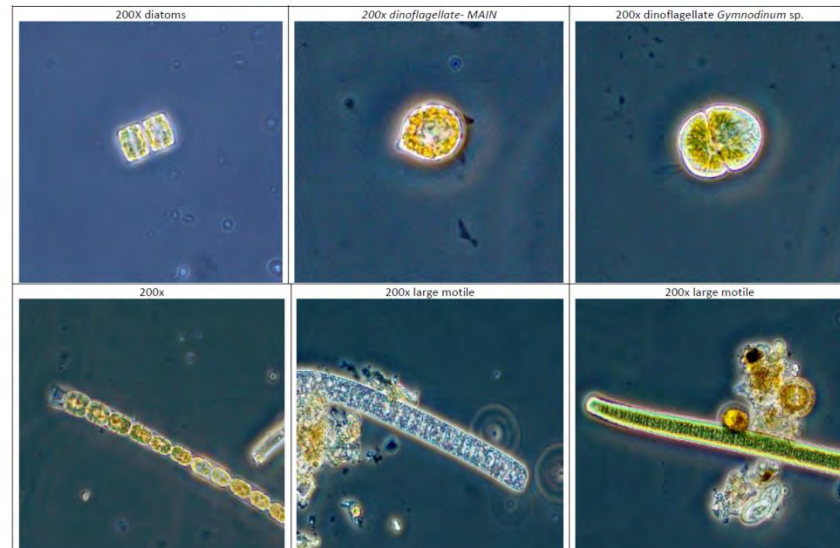
**Discussion:**

The phytoplankton population appears to be mostly freshwater diatoms and dinoflagellates. Some genera that were detected were estuarine in nature and found in marine waters as well. Please see images below and note the main and secondary abundance levels in the description with the images.

## Slater Mill Sample 7-21-15



## School Street Sample Net 7-23-15



# Most Abundant Phytoplankton

## Preliminary Findings:

- ✓ Many similar diatoms and dinoflagellates found at both locations
- ✓ Most abundant phytoplankton at the School Street location may include:
  - *Scrippsiella*
  - *Alexandrium*
- ✓ Awaiting more expert findings from URI-GSO

	Slater Mill (Upstream sample)	School Street (Seekonk River Sample)
Flagellates	pos	pos
Ciliates	pos	pos
Pennate	pos	pos
<i>Cylindrotheca</i> sp.		pos
<i>Micractinium</i>	pos	pos
<i>Scenedesmus</i> sp.	pos	pos
<i>Striatella</i>	pos	
<i>Bacillaria</i>	pos	
<i>Navicula</i>	pos	pos
<i>Peridinium</i> sp.	pos	pos



# “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) Award for excellence in e-media education
- Visit [www.narrabay.com](http://www.narrabay.com)

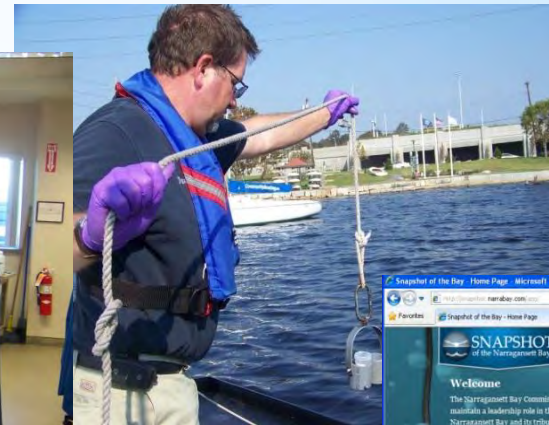
The screenshot shows the 'Snapshot of the Bay' website interface. At the top, there's a navigation bar with 'WATER QUALITY MONITORING', 'BUOYS', 'GLOSSARY', and 'PUBLICATIONS'. The main content area is divided into several sections:

- Welcome:** A text block explaining the NBC's mission statement.
- Providence Conditions:** A section with live conditions (6:17:38 AM) showing wind (11 mph NNE) and temperature (50° Air, 49° Water). It also includes tide predictions for the next few hours.
- Bullock Reach:** A table of water quality data for the Bullock Reach buoy. The table includes columns for 'Sonde Location' (Surface, Middle, Bottom), 'Depth (m)', 'Temperature (C)', 'Salinity (ppt)', 'Dis. Oxygen (mg/L)', 'pH', 'Chlorophyll (mg/L)', and 'Turbidity (NTU)'. The data is for the last update on 6/16/13 at 7:36 AM.
- Phillipsdale:** A similar table of water quality data for the Phillipsdale buoy, also for the last update on 6/16/13 at 7:33 AM.
- Map:** A map of the Providence area with a red dot indicating the location of the Bullock Reach buoy.
- Images:** Several small images showing buoys in the water, a boat, and the Phillipsdale Lighthouse.
- Summary of Water Quality in the Bay:** A section with links to 'Fixed Site Network' and 'Historical Blog', and a note about Phillipsdale surface temperatures ranging between 16.7°C and 26.6°C during the weeks of May 29th to June 5th.

# Any Questions?

## *Special Thanks to:*

- ▶ *NBC Water Quality Science Team: John Motta, Jim Kelly, Eliza Moore, Christine Comeau, Pam Reitsma & Terri Breeden*
- ▶ *NBC Monitoring & Lab Staff*

A screenshot of the 'Snapshot of the Bay' website. The page features a navigation bar with links for 'HOME PAGE', 'WATER QUALITY MONITORING', 'BOUYS', 'GLOSSARY', and 'PUBLICATIONS'. The main content area includes a 'Welcome' message, 'Providence Conditions' with a live data table, a map of the bay, and sections for 'Bullock Reach' and 'Phillipsdale' with their respective data tables. At the bottom, there is a 'Summary of Water Quality in the Bay' section with a 'Fixed Site Network' map and a 'Winds of Bay' section.

Live Conditions: 9/17/08
Water Temperature: 68°F
Water Clarity: 11 cm
Water Turbidity: 0.08 NTU
Providence Tide Prediction: 0.1 m
Providence Tide Prediction: 0.1 m

Last Update: 8/17/08 10:00 AM
Water Temperature: 68.0
Water Clarity: 11.0
Water Turbidity: 0.08
Providence Tide Prediction: 0.1
Providence Tide Prediction: 0.1

Last Update: 8/17/08 10:00 AM
Water Temperature: 68.0
Water Clarity: 11.0
Water Turbidity: 0.08
Providence Tide Prediction: 0.1
Providence Tide Prediction: 0.1

Data and Presentations are available on NBC Website at <http://snapshot.narrabay.com>

