



Comprehensive Environmental Monitoring in a Rapidly Changing Estuary

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Narragansett Bay Commission

Narragansett Bay Commission (NBC) Mission:

To maintain a leadership role in the protection and enhancement of water quality in Narragansett Bay and its tributaries by providing safe and reliable wastewater collection and treatment services to its customers at a reasonable cost.

What WWTF changes are contributing to changes in the Providence River Estuary?

- Nitrogen loadings to Narragansett Bay watershed have decreased by over 50% in recent years per the 2004 RI Nutrient Mandate in 11 Providence River Estuary Wastewater Treatment Facilities (WWTFs) (Figure 1)
- Similar nutrient reductions enacted by other WWTFs in the Watershed

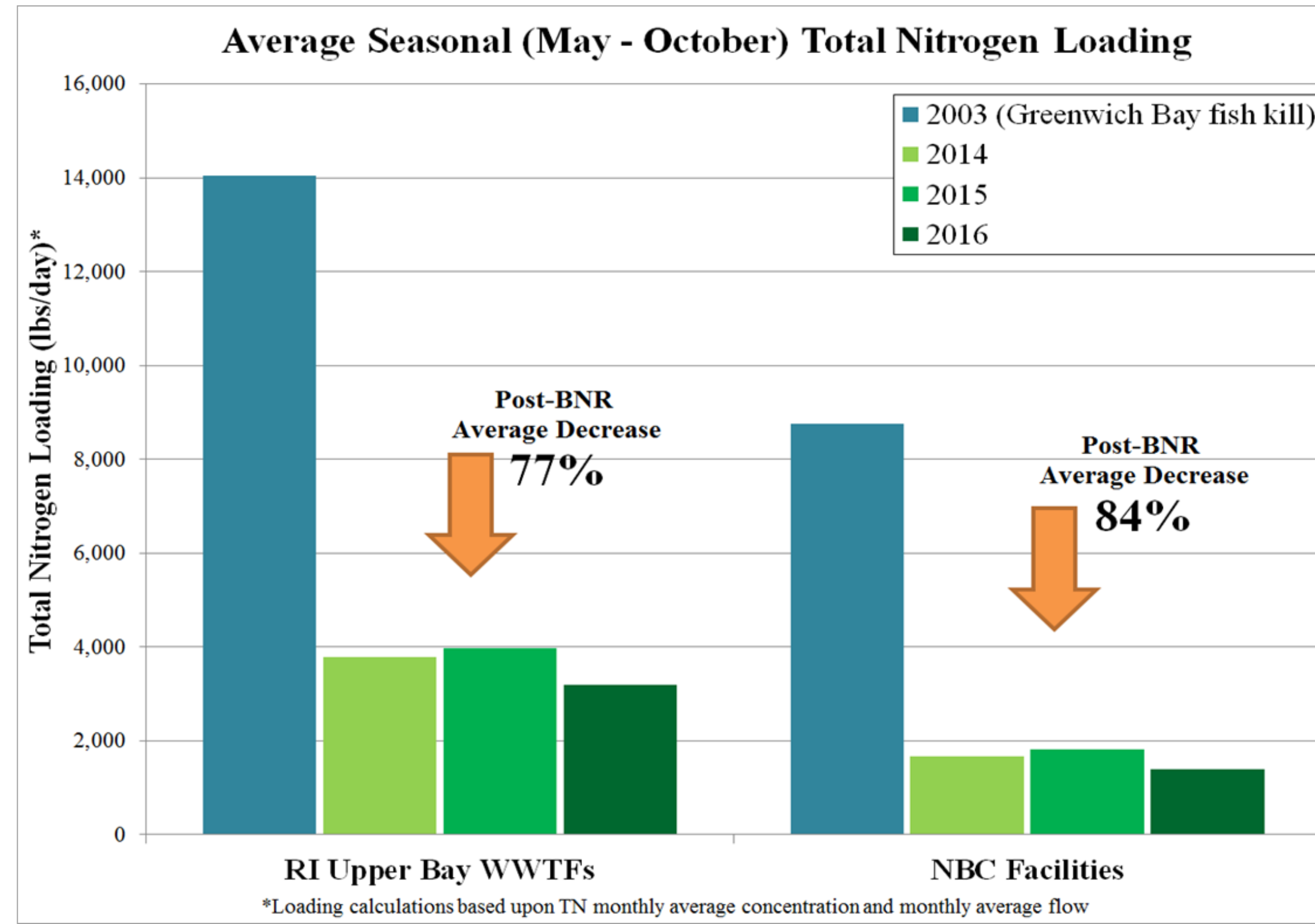


Figure 1: Average Seasonal TN Loading at the 11 Providence River (PR) Estuary WWTFs (2014-2016) Prior to biological nutrient reduction (BNR) implementation, average seasonal TN loading was 14,000 lbs/day

- Bacteria concentrations in the Providence River have dropped dramatically following Phase I of the NBC CSO Abatement Project
- 62-million gallon capacity underground tunnel for storing wet weather combined sewer overflow (CSO) flows during storm events. Flows then receive full advanced secondary wastewater treatment.

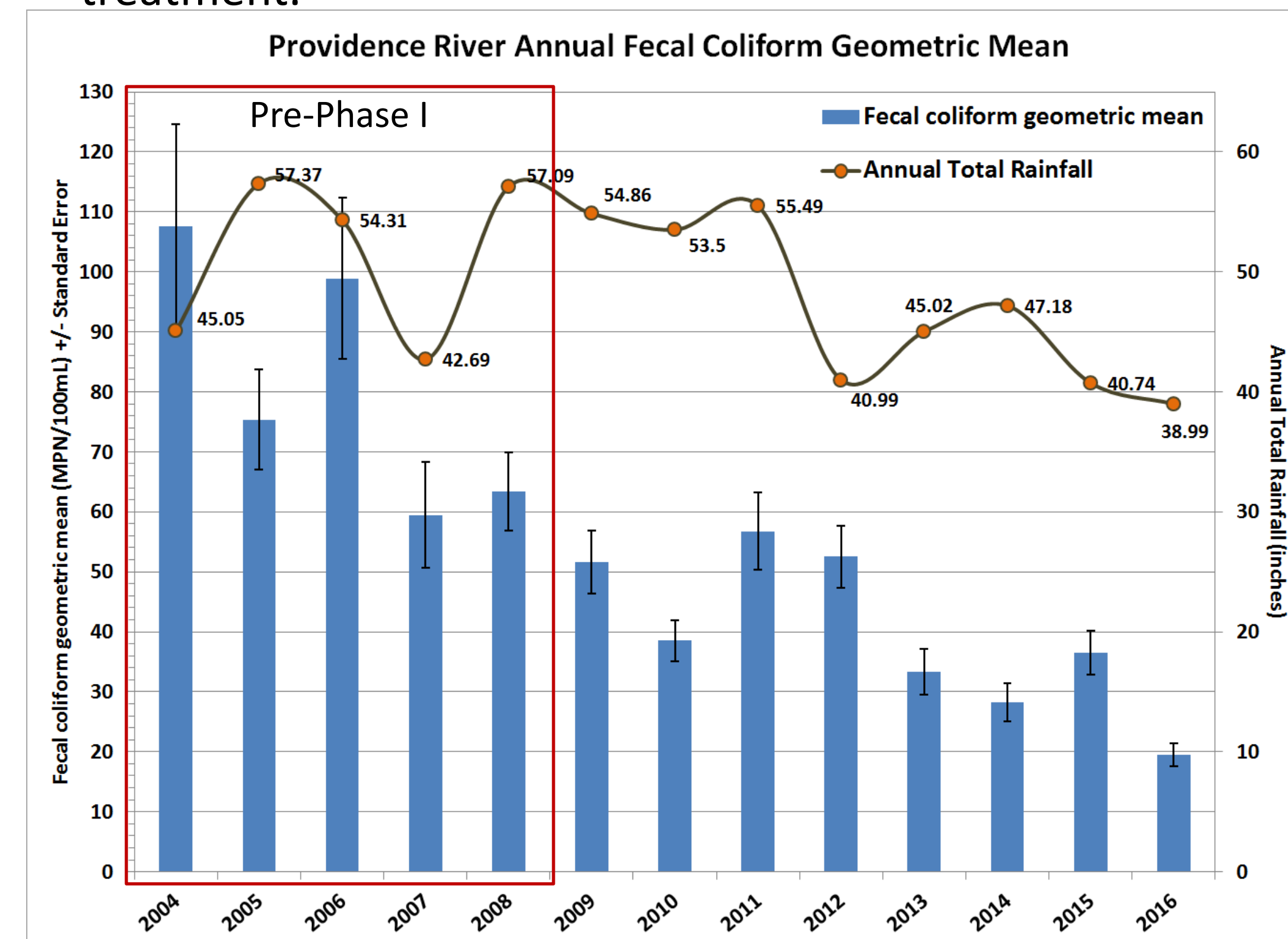


Figure 2: Providence River Annual Fecal coliform Geometric Mean (2004-2016)

Why Does NBC Monitor Water Quality in the Providence River Estuary?

- Monitoring provides data to document water quality changes associated with NBC's construction projects and WWTF upgrades
- Tributary River & Providence River Estuary Bacteria Monitoring
 - Capture effects of CSO discharges on tributary rivers and receiving waters in the NBC Service Area
- Tributary River & Providence River Estuary Nutrient Monitoring
 - Capture changes in receiving waters nutrient concentrations post-total nitrogen reductions
- New monitoring programs are developed as more comprehensive metrics are needed to make informed decisions with guidance from the findings of research institutions

All data available on: <http://snapshot.narrabay.com> or via e-mail at: snapshot@narrabay.com for further analysis

Acknowledgments: Thank you to the NBC EMMA Monitors who collect all monitoring data for us to analyze. Thank you to NBC Engineering Department for printing assistance.

How Do We Monitor Water Quality in Narragansett Bay?

NBC Receiving Waters Monitoring

Bacteria (2004 – present)

- 23 River stations sampled weekly
- 20 Bay stations sampled twice a month
- Fecal coliform sampled at all stations
- Subset sampled for Enterococci

Station	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Seekonk River														
Division St. Dock	385	464	229	441	222	213	441	430	343	172	295	419	109	97
Bishop Point	620	394	280	279	364	136	216	338	224	354	236	292	111	92
Off BP Outfall	808	339	352	455	565	163	327	509	211	302	147	252	108	131
Phillipsdale Landing	1317	320	223	156	542	258	120	190	255	223	64	169	46	151
Narragansett Boating Center	601	263	234	126	240	207	159	221	224	297	57	140	49	90
Crook Point	456	295	328	146	193	265	121	103	337	219	57	129	61	74
India Point Park	425	389	270	169	163	180	98	275	243	247	62	51	48	71
Point St. Bridge	4335	2953	8258	945	811	3308	533	680	1136	568	429	940	848	351
Collier Point Park	459	294	354	242	166	277	179	276	461	258	114	130	45	111
Off FP Outfall	226	242	235	101	114	213	40	170	94	98	40	76	35	39
South FP East	103	91	59	50	29	30	20	45	82	57	23	54	17	24
Save the Bay	51	79	62	43	56	52	70	61	63	18	37	14	32	
Edgewood Yacht Club	85	58	105	52	35	25	30	43	39	16	43	29	32	
Pawtucket/Providence Junction	79	90	199	106	49	113	17	54	103	41	34	57	37	49
Gaspee Point	53	55	80	40	25	18	18	27	41	21	10	38	13	26
Bullock Neck	34	14	33	22	12	13	10	16	28	17	8	12	5	15
Bullock Reach Buoy	37	32	64	17	13	31	13	19	35	22	9	21	27	17
Shawomet	16	52	18	17	15	9	19	25	15	12	12	9	15	
North of Nayatt Point	11	19	14	8	10	6	15	14	9	6	8	4	14	
Conimicut Point	22	20	36	8	15	11	12	11	19	10	7	17	5	16

Figure 3: Seasonal (May – October) Geomean at Providence River Estuary Stations (MPN/100mL) (2004-16) Color coding based on RI State fecal coliform standards for saltwater primary contact (≤ 50) [orange] and shellfishing (≤ 14) [green]

Nutrients (2005 – present)

- Parameters: NO_2 , NO_3 , Ammonia, TDN, TN, Orthophosphate, and Silicate

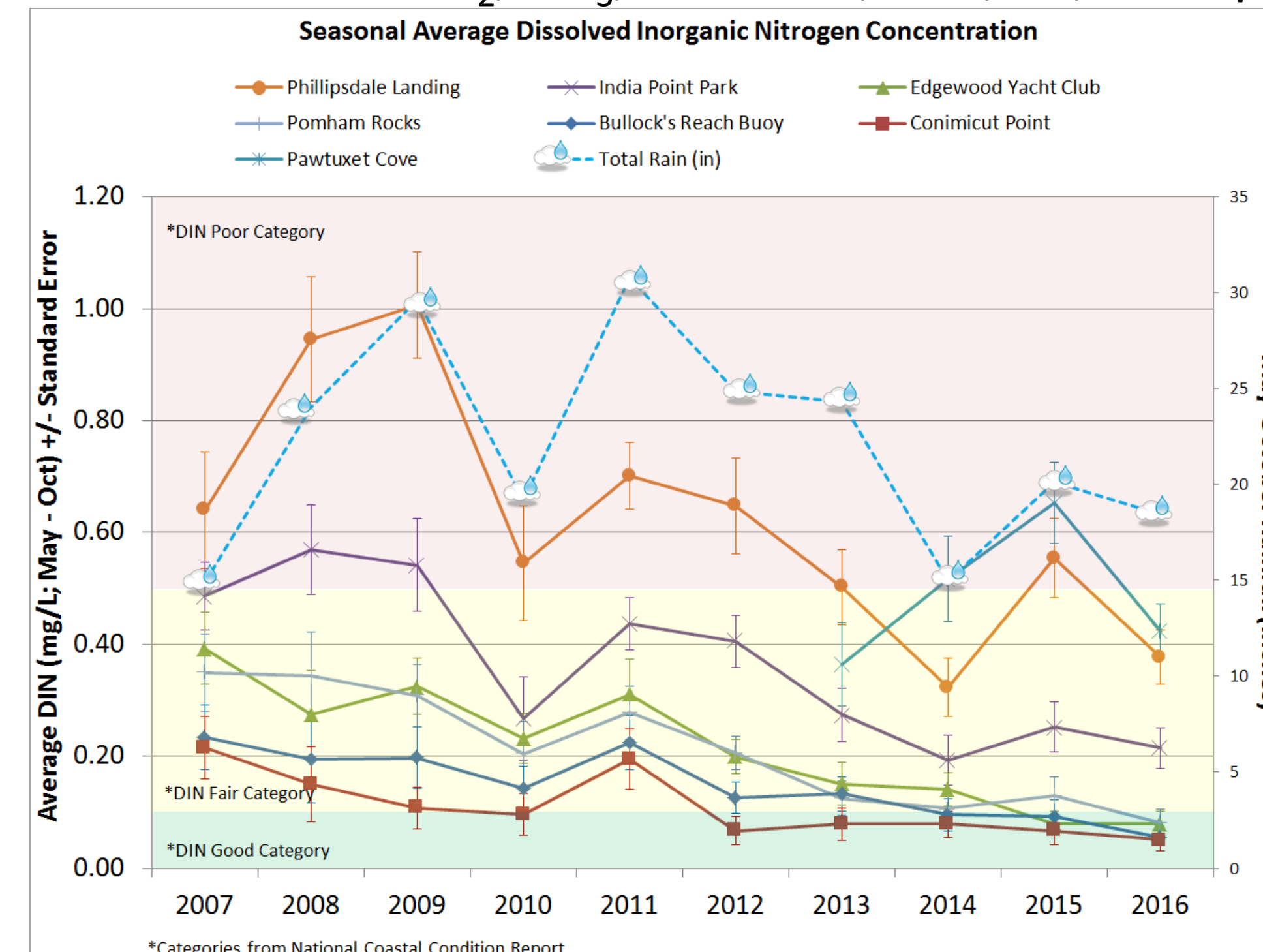


Figure 4: Seasonal (May – October) Average DIN Concentrations at PR Estuary Stations (2007-16) DIN categories based on standards set in National Coastal Condition Report

Fixed Site Buoys (2003 – present) [Bullock Reach & Phillipsdale Landing]

- In conjunction with the Narragansett Bay Fixed Site Monitoring Network
- Parameters: temperature, salinity, DO, pH, chl α , and turbidity at Bullock Reach
- Data collected at 15-min intervals
- Data collected at multiple depths: surface, middle at Bullock Reach, and bottom
- Operational during the summer (May-October)

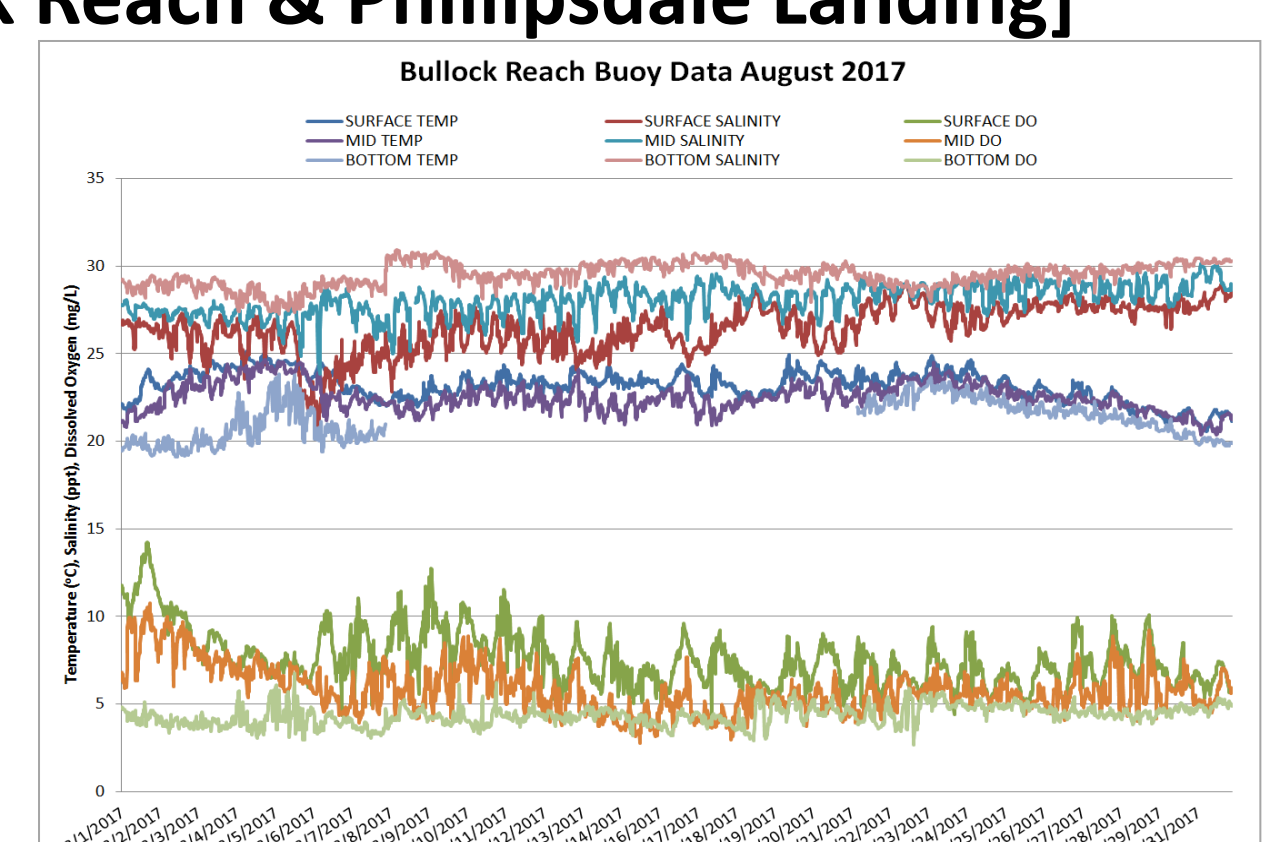


Figure 5: Bullock Reach Buoy Data (August 2017)

Benthic Video (2014 – present) [3 Transects]

- Monitor for changes in benthic community and habitat structure over time and in response to infrastructure improvement
- Transect monitoring conducted year-round, weather permitting
- Cross-training efforts in progress with DEM, TNC, and EPA
- CERF Poster: Benthic Video Monitoring in Narragansett Bay – Observations using the CMECS Language



Figure 6: Bottom at Edgewood (06/08/17)



Figure 7: Sea Robin observed at Edgewood (06/13/17)

NBC Receiving Waters Monitoring

Water Clarity (2009 – present) [8 Stations]

- Secchi data collected weekly
- Photosynthetic active radiation (PAR) data also collected with water column profiles
- Secchi data used in Narragansett Bay Estuary Program's (NBEP) 2017 Report

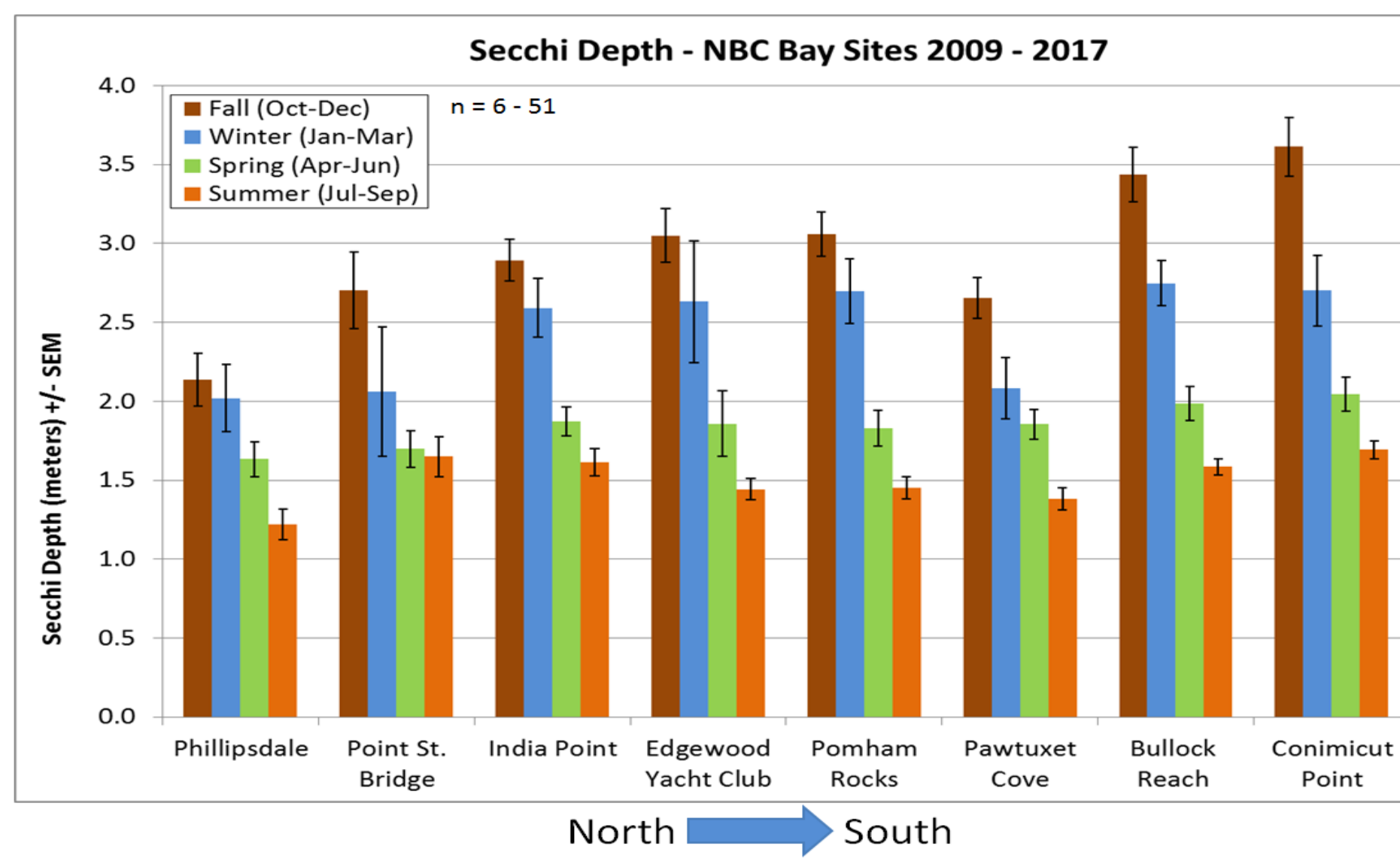


Figure 8: Average Secchi Depth by Season at PR Estuary Stations (2009-17)

Chlorophyll α (2005 – present) [7 Stations]

- Sampled twice a month with nutrients
- Chlorophyll data used in NBEP's 2017 Report

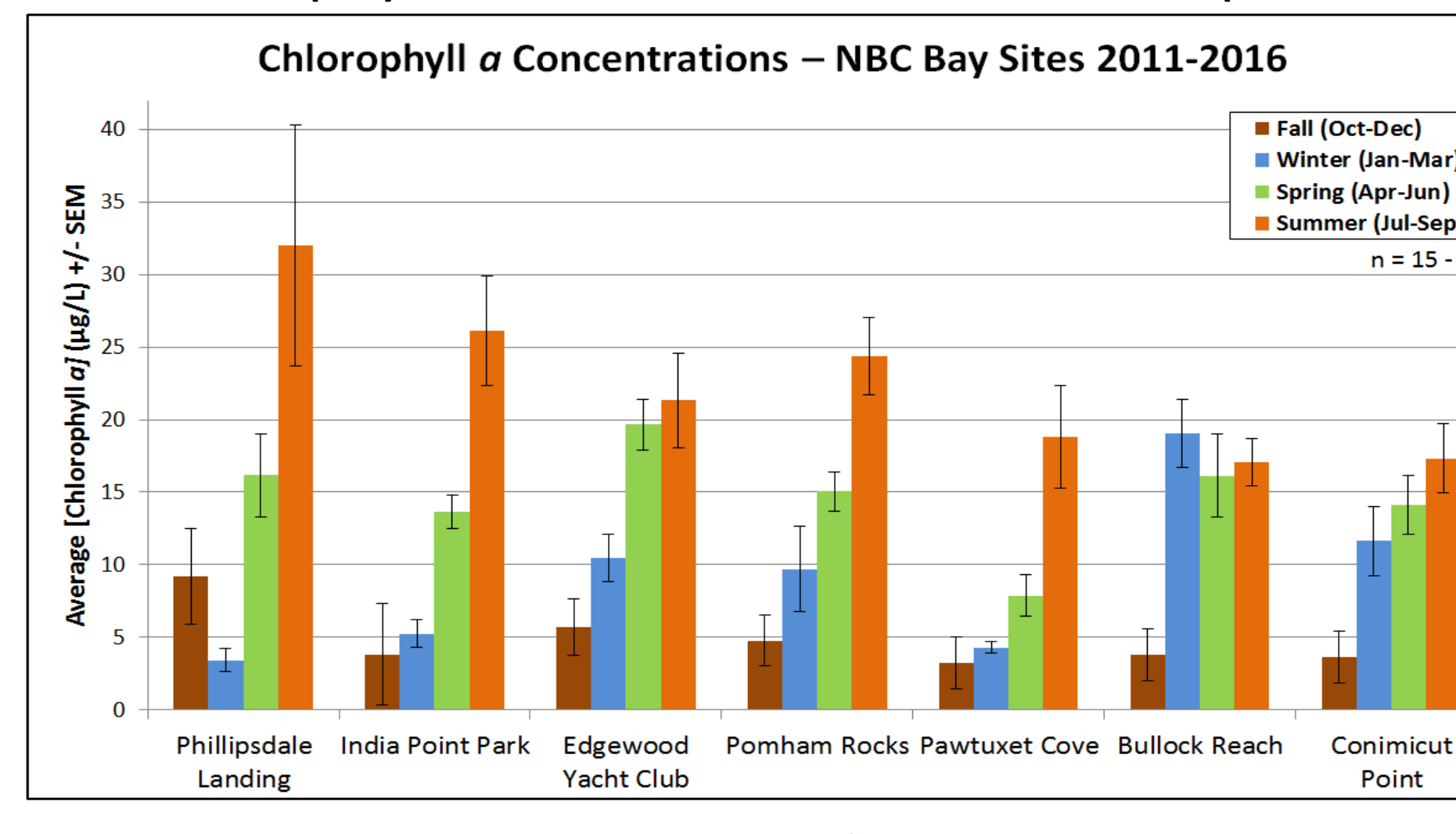


Figure 9: Average Chl α concentration by season at PR Estuary Stations (2011-16)

Surface Mapping (2004 – present)

- Collected weekly
- Continuous surface water quality data collected during routine surveys
- Parameters: temperature, salinity, DO, pH, and chl α

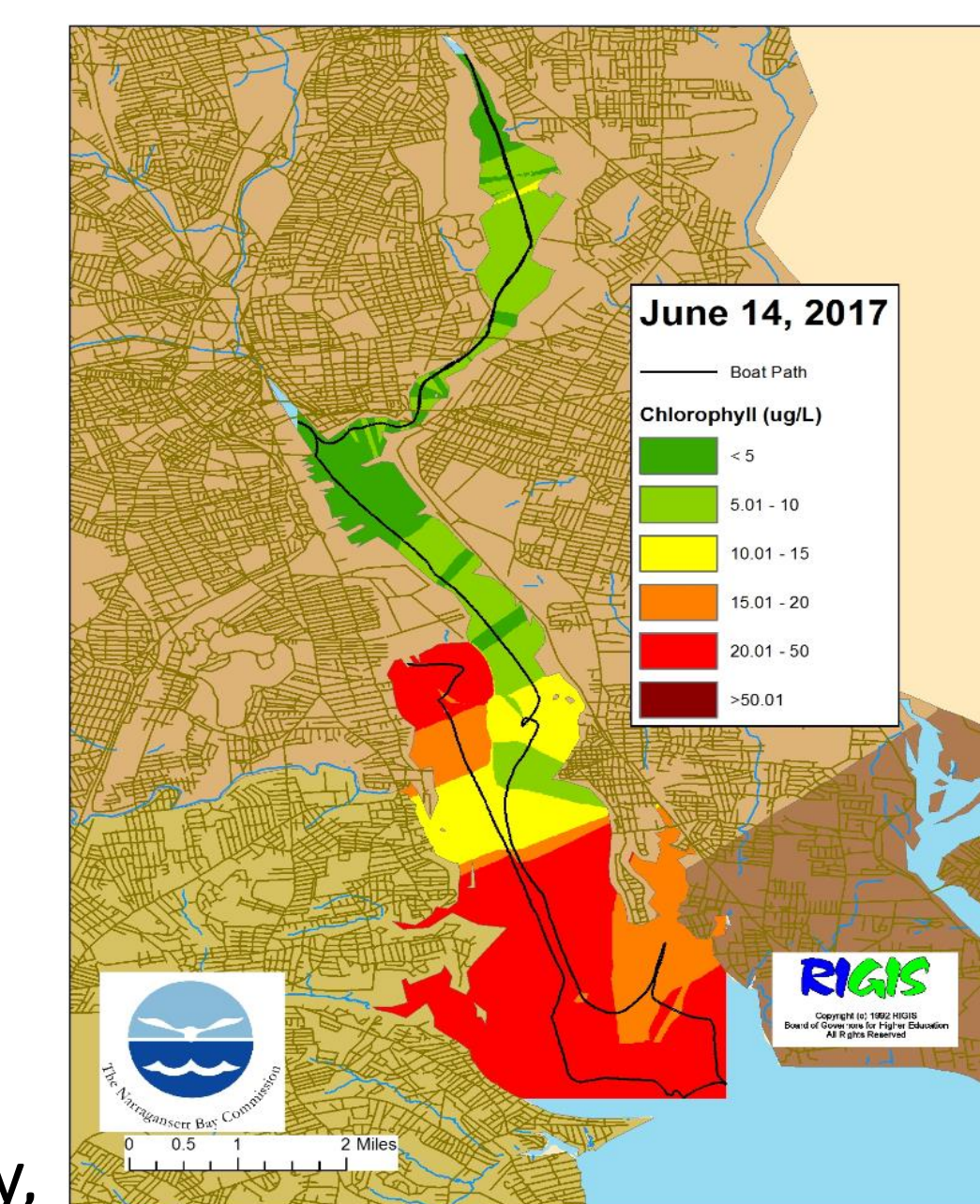


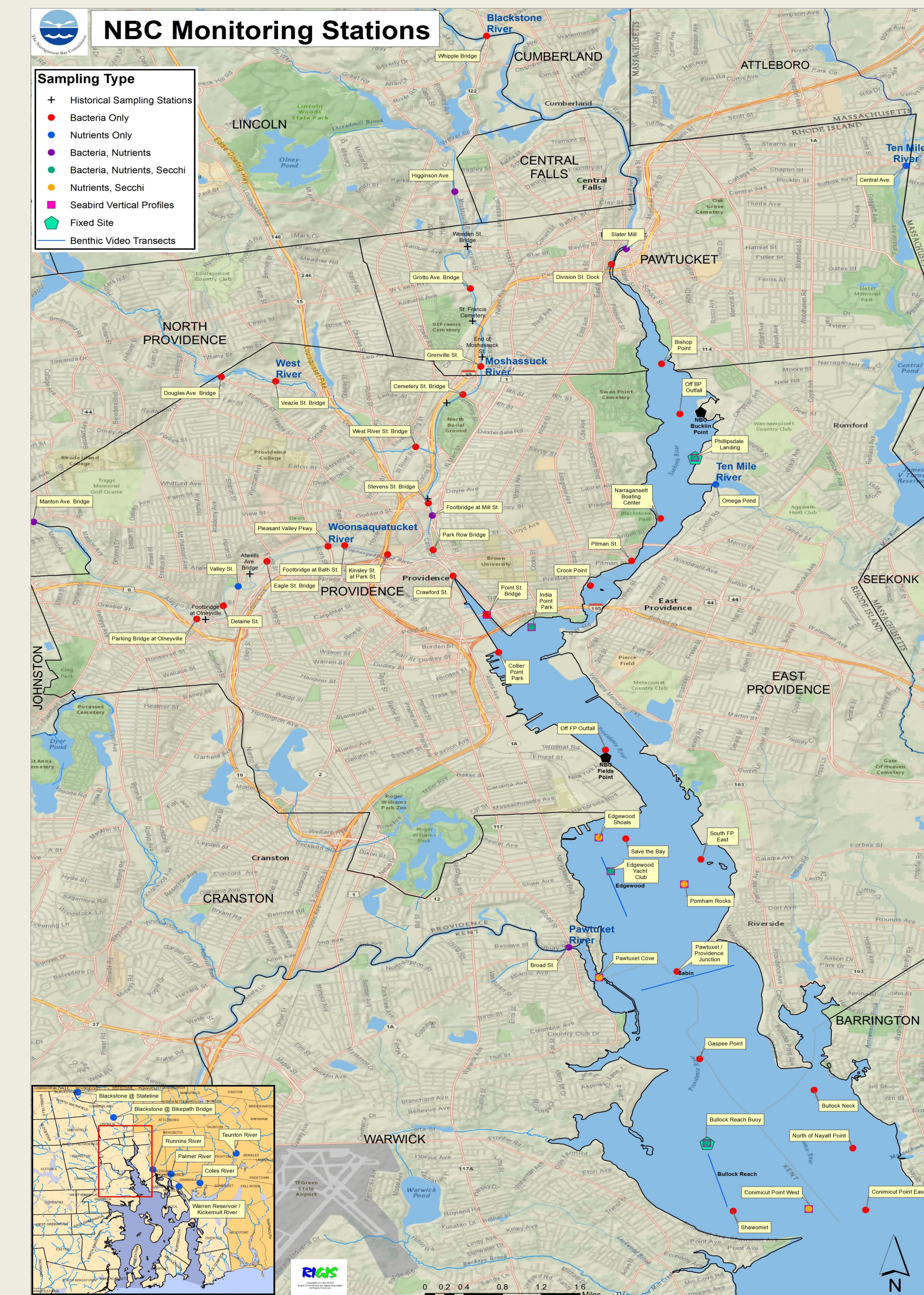
Figure 10: Interpolated Chl α concentration for PR Estuary survey (06/14/17)

Phytoplankton ID & Abundance (2013 – present) [Bullock Reach]

- Sampled twice a month
- Quantitative counts of common taxa
- Qualitative presence/absence analysis of rare taxa
- CERF Talk: Upper Narragansett Bay Phytoplankton Community Characterization Post-Wastewater Treatment Facility Nitrogen Load Reductions



Figure 11: Chaetoceros spp. chain



Water Column Profiles (2007 – present) [8 Stations]

- Collected weekly
- Utilized to assess hypoxic conditions
- Parameters:
 - Depth
 - Density
 - Temperature
 - Salinity
 - DO
 - PAR
 - Fluorescence

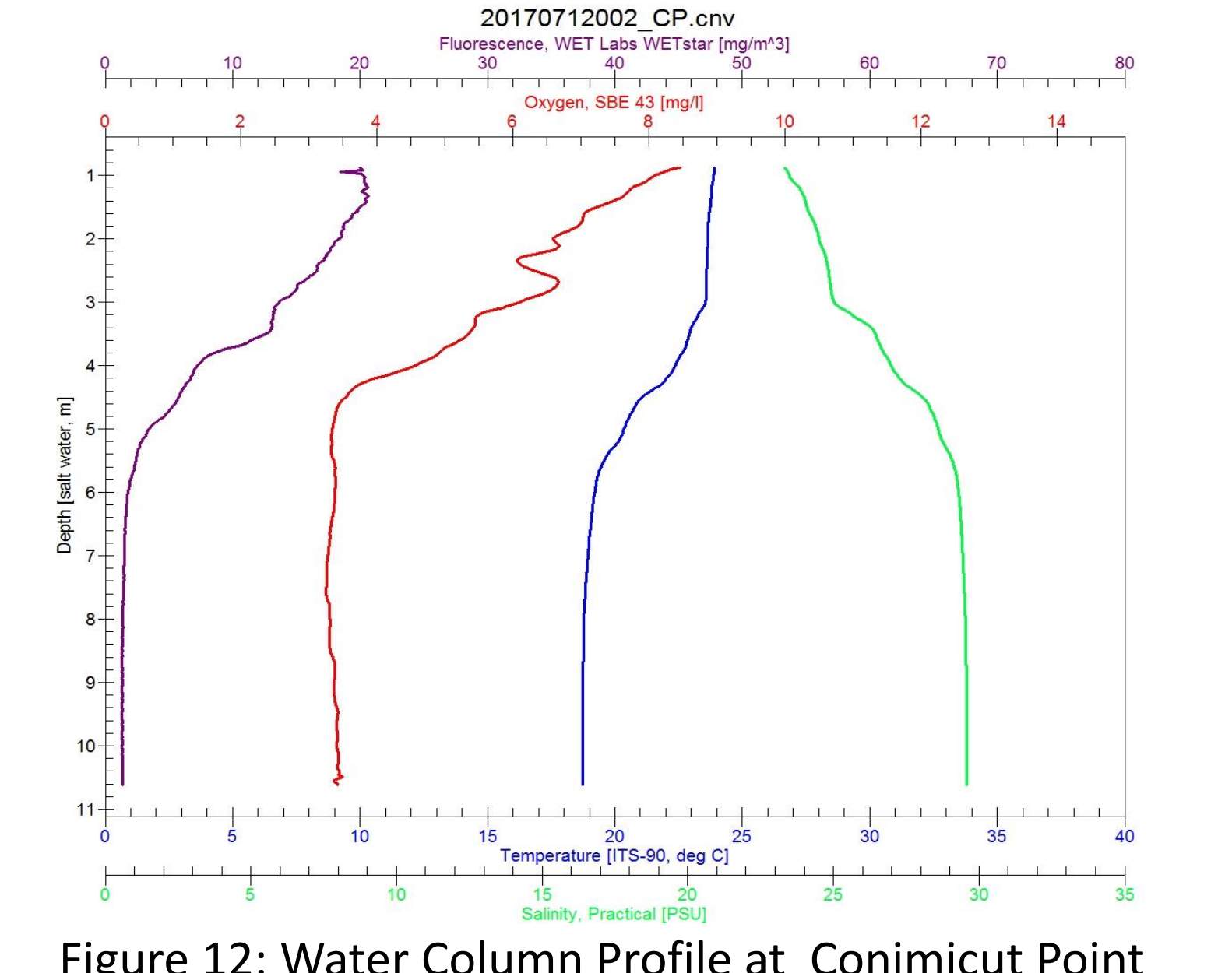


Figure 12: Water Column Profile at Conimicut Point (07/12/2017)

What have we learned from our monitoring?

- Comprehensive monitoring results are an excellent tool in evaluating the impacts of water quality improvement projects.
- Since NBC TN loading reductions of around 84%, DIN levels in the Bay have dropped with more stations in the "Good" category (Figures 1 and 4)
 - 50% reduction of TN has been achieved
- Bacteria levels in the Bay meet primary contact criteria 61% of the time after CSO Phases I and II (Figure 3)
 - Changes in RI DEM conditional shellfishing area closure criteria in 2011 and 2017 led to more days open to shellfishing
- Monitoring must continue to evaluate impacts over longer time scales.