THE NARRAGANSETT BAY COMMISSION

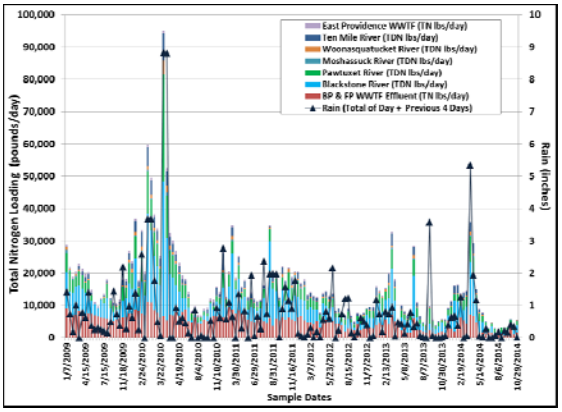
Division of Planning, Policy & Regulation

PROJECT HIGHLIGHT

The Relationship between Rainfall, Nutrients, and Hypoxia

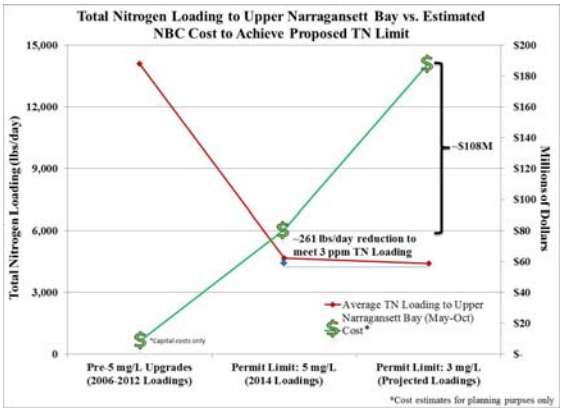
Last revised: 12/1/14

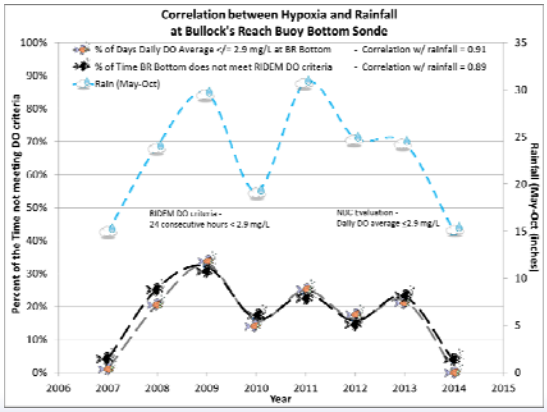
Rainfall and Nutrients: It has long been known that nutrient loading within the Narragansett Bay watershed increases with rainfall due to increased river flow and stormwater runoff. Such increased nutrient loading is often linked to an increase in hypoxia within the Bay. To track this phenomenon since 2006, the Narragansett Bay Commission (NBC) has collected nutrient samples from area rivers at the point they enter the Bay to determine nitrogen loading coming from these sources. The graph to the right shows measured nutrient loading from the NBC facilities along with loading from local rivers and the East Providence WWTF, which also discharges to the upper Bay. The black triangles represent the total rainfall on the sample day plus the previous 4 days. The graph illustrates that most high peaks of nitrogen loading are accompanied by high peaks in rainfall.



Point Source vs. Non-Point Source Nutrient Input: Historically, WWTF discharge has been considered the dominant source of nitrogen loading to the Bay. However, under new permit limits and with better treatment technology, WWTFs around the state are decreasing point-source nitrogen inputs, leading to non-point sources (e.g., rivers, stormwater) becoming increasingly more dominant as sources of nitrogen to the Bay. The table and graph compares estimated average loading values for total nitrogen (TN) from WWTFs and total dissolved nitrogen from rivers for 2006 through 2014 for all sources to the upper Bay north of Conimicut Point during the permit season of May through October. The loadings are separated into pre- (2006–2012) and post-nitrogen-treatment upgrades (2014) at the NBC facilities, as well as an estimate of loadings if NBC facilities decreased to 3 mg/L total nitrogen. Prior to nitrogen upgrades, Bucklin Point contributed 1,220 lbs/day of TN, while Field's Point's TN loading was 4,363 lbs/day. After upgrades, the NBC facilities reduced their TN loads to 587 lbs/day at Bucklin Point and 1,052 lbs/day at Field's Point. **The average nitrogen loading to the upper Bay from all sources has been reduced from 14,536 lbs/day pre-nitrogen upgrades to 4,698 lbs/day post-nitrogen upgrades: a 67.7% reduction.** Future upgrades to reduce TN load at the NBC facilities would only reduce the load by approximately 261 lbs/day at a cost of approximately $108 million.

Point & Non-Point Nitrogen Sources north of Conimicut Point (lbs/day)	2006-2012 Average Loading	2014 Average Loading	Projected Loadings
Bucklin Point WWTF	1,220	587	435
Field's Point WWTF	4,363	1,052	943
Blackstone River	4,623	1,571	1,571
Moshassuck River	186	64	64
Woonasquatucket River	458	111	111
Pawtuxet River	2,286	1,062	1,062
Ten Mile River	851	164	164
East Providence WWTF	548	348	348
Total Contribution	**14,535**	**4,959**	**4,698**





Rainfall and Hypoxia: The NBC maintains water quality instruments at Bullock's Reach, a site in the lower Providence River that has been listed as impaired for dissolved oxygen (DO). Both the NBC and the RIDEM evaluate the DO data at this location to determine compliance with DO criteria, which states that a daily DO average concentration of ≤2.9 mg/L (hypoxia) is detrimental to aquatic larval organisms. The graph to the right shows the correlation between rainfall and the percent of time such hypoxic conditions were observed at Bullock's Reach since 2007. Statistical analysis of these data reveals that the relationship is very strong, with rainfall patterns explaining up to 91% of the pattern of hypoxia. Other research has supported these findings.

For further information, please contact the EMDA Section at:
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Visit the NBC's websites – www.narrabay.com & http://snapshot.narrabay.com/app/
for information on all Narragansett Bay Commission news, as well as to download NBC water quality data