Evaluation of Advanced OWTS Performance within the Greater Narragansett Bay Watershed

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The Nitrogen Problem

OWTS: 30% of RI households

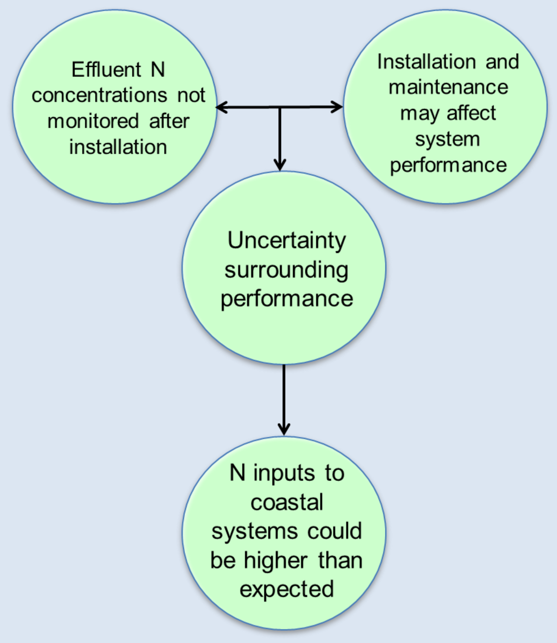
Wastewater can be a significant source of nitrogen (N) to coastal ecosystems (Valiela et al.,1992). Excess N inputs to these ecosystems can lead to eutrophication, which may result in a loss of ecosystem services (Carpenter et al., 1998). This is an ongoing problem in Rhode Island (Bergondo et al., 2005).

Reducing Nitrogen Inputs

- To reduce N inputs, Rhode Island requires the use of advanced N-removal OWTS in N-sensitive areas.
- Final effluent total nitrogen (TN) concentrations are limited to ≤ 19 mg N/L.

Advanced N-Removal OWTS: 50-75% N Removal

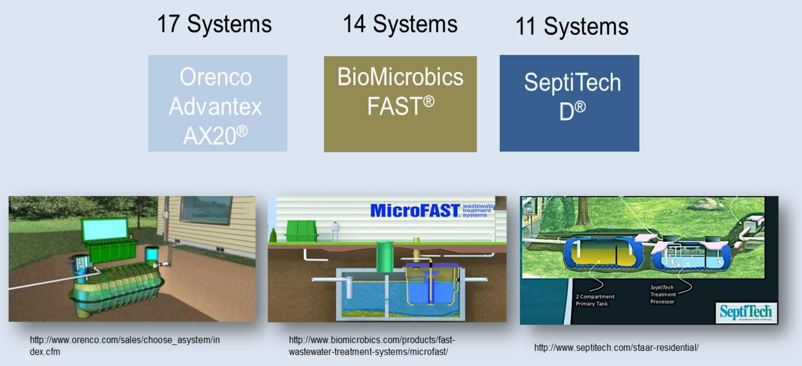
Advanced OWTS in RI



Effluent N concentrations from advanced OWTS are not monitored in RI, which leaves uncertainty surrounding the performance of these systems.

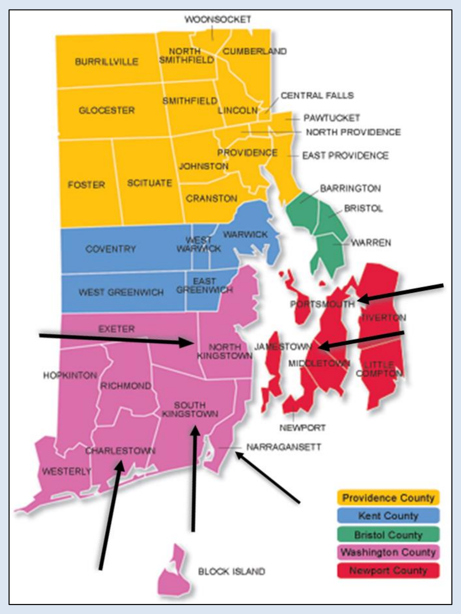
Methods

Study Systems



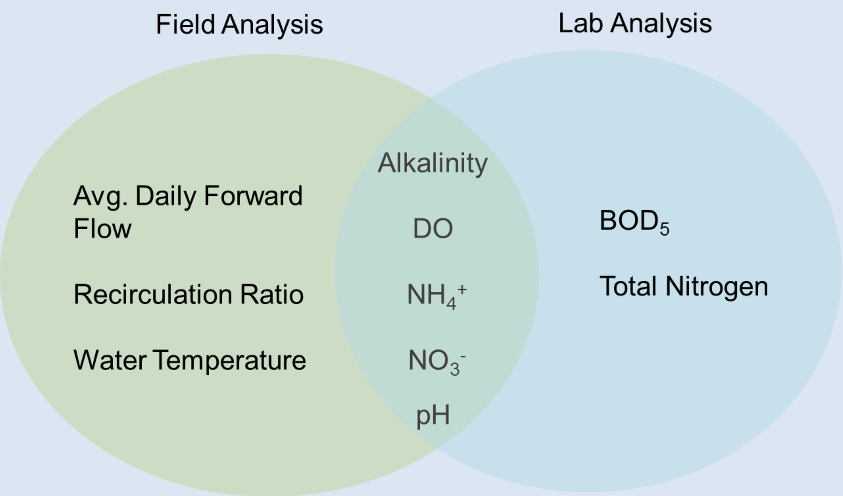
We sampled the three most commonly installed advanced N-removal OWTS in Rhode Island from March 2015 to August 2016.

Sampling Locations



All study systems were located within the Greater Narragansett Bay Watershed, RI.

Wastewater Properties



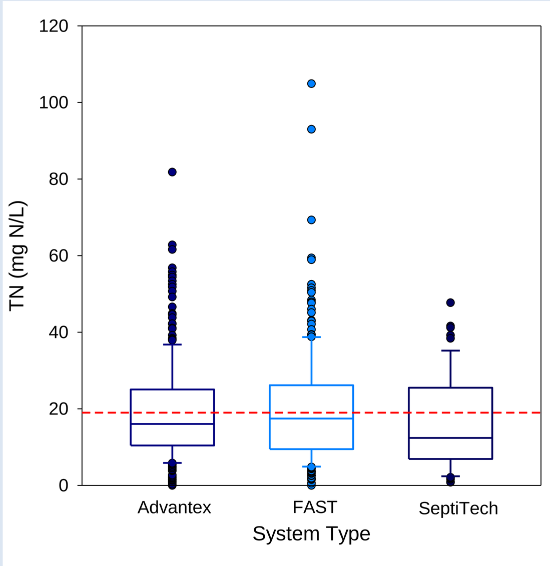
We analyzed effluent for a variety of wastewater properties in the laboratory and field.

Statistical Analysis

We used best subsets multiple regression to determine the wastewater properties that best predict effluent TN.

Results

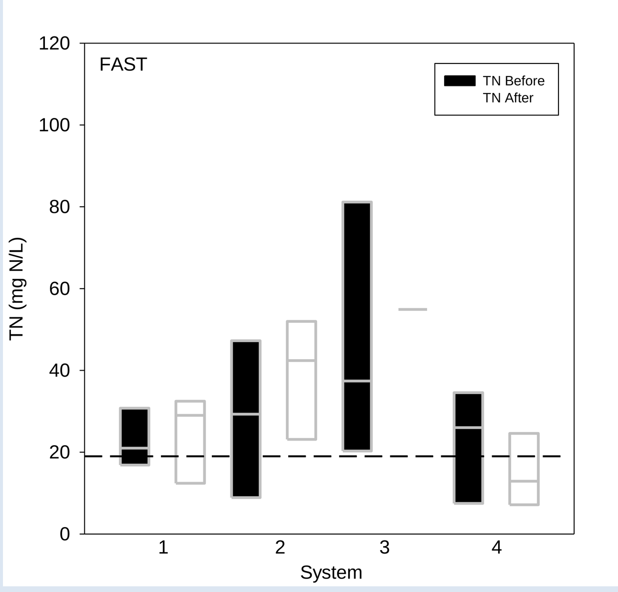
Distribution of Effluent TN Concentrations



Concentration of final effluent total nitrogen (TN) for all systems within a technology type from March 2015 to August 2016. n = 141,112, and 30 for Advantex, FAST, and SeptiTech systems, respectively. Dashed line represents 19 mg N/L standard.

Median final effluent TN concentrations were below 19 mg N/L for all technologies.

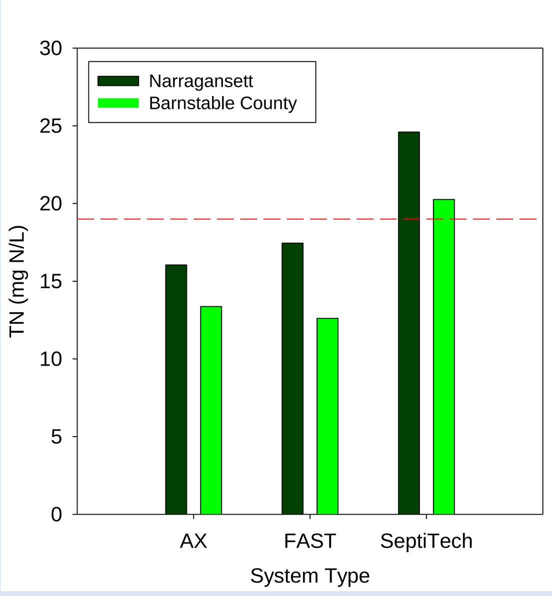
Adjustments to Underperforming Systems



Median (n=4) final effluent TN concentrations for underperforming FAST systems before adjustments (March 2015 to June 2015) compared to after adjustments (March 2016 to June 2016). The dashed line represents19 mg N/L TN standard.

In most cases, adjustments to underperforming systems did not result in improved performance.

Comparison to Barnstable County Study



Median (n= 450-923) effluent TN concentrations for Narragansett systems compared to Barnstable County, MA systems collected from March 2015 to August 2016.

Median effluent TN concentrations for all system types were higher in Rhode Island than Barnstable County, MA, where systems are visited quarterly and effluent is analyzed for wastewater properties.

Significant Predictors of Effluent TN

System type	Property	Coefficient	P	R^2
Advantex	Constant	**10.5**	**0.004**	0.44
	Ammonium	**1.0**	**<0.001**	
	Nitrate	**0.4**	**0.032**	
	Alkalinity	**-0.1**	**0.017**	
FAST	Constant	**7.6**	<0.001	0.71
	Ammonium	**0.5**	**<0.001**	
	Nitrate	**0.6**	**<0.001**	
	Avg. Forward Flow	**-0.0**	**0.003**	
	BOD	**0.1**	**<0.001**	
SeptiTech	Constant	**-78.2**	**0.028**	0.81
	Ammonium	**0.5**	**0.002**	
	Effluent Temp.	**2.2**	**0.016**	
	Recirc. Ratio	7.7	0.098	

Results of best subsets multiple linear regression analysis to predict effluent TN concentration based on effluent properties using data collected from March 2015 to August 2016.

Significant predictors of effluent TN varied by system type.

Conclusions

- The compliance rate of advanced N-removal OWTS in RI ranges from 50% to 65%, depending on system type.
- For the majority of underperforming systems, adjustments did not seem to improve N removal.
- Differences in regulatory requirements for monitoring influences management and may affect performance.
- Systems perform better in Barnstable County MA, where quarterly site visits including effluent analysis are required.
- Ammonium, nitrate, BOD, alkalinity, effluent temperature, and average forward flow are significant predictors of TN.

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Carpenter, S., Caraco, N., Correll, D., Howarth, W., Sharpley, A., and Smith, V. (1998). Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological applications*, *8*(3), 559-568.

Valiela, I., Foreman, K., LaMontagne, M., Hersh, D., Costa, J., Peckol, P., and Brawley, J. (1992). Couplings of watersheds and coastal waters: sources and consequences of nutrient enrichment in Waquoit Bay, Massachusetts. *Estuaries*, *15*(4), 443-457.