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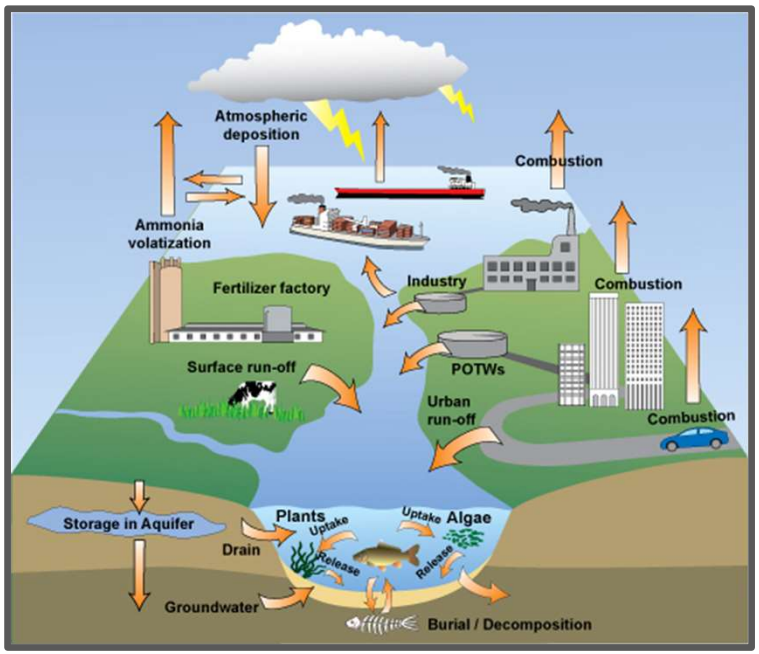
SMAST

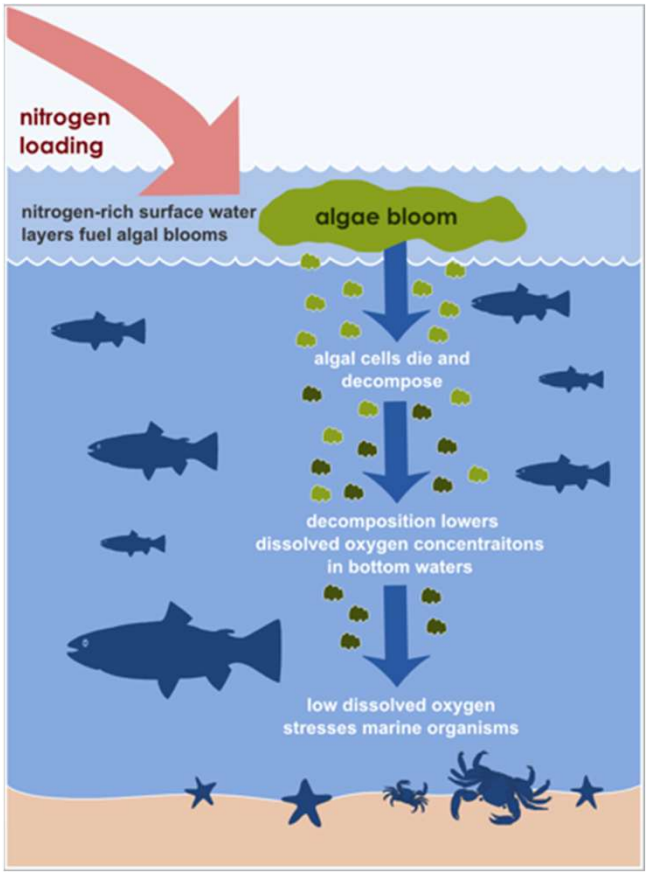
Public Enemy No 1: Nitrogen

Down Island Coastal Ponds
Speaker Series

April 4, 2024

N inputs to estuaries & water column effects

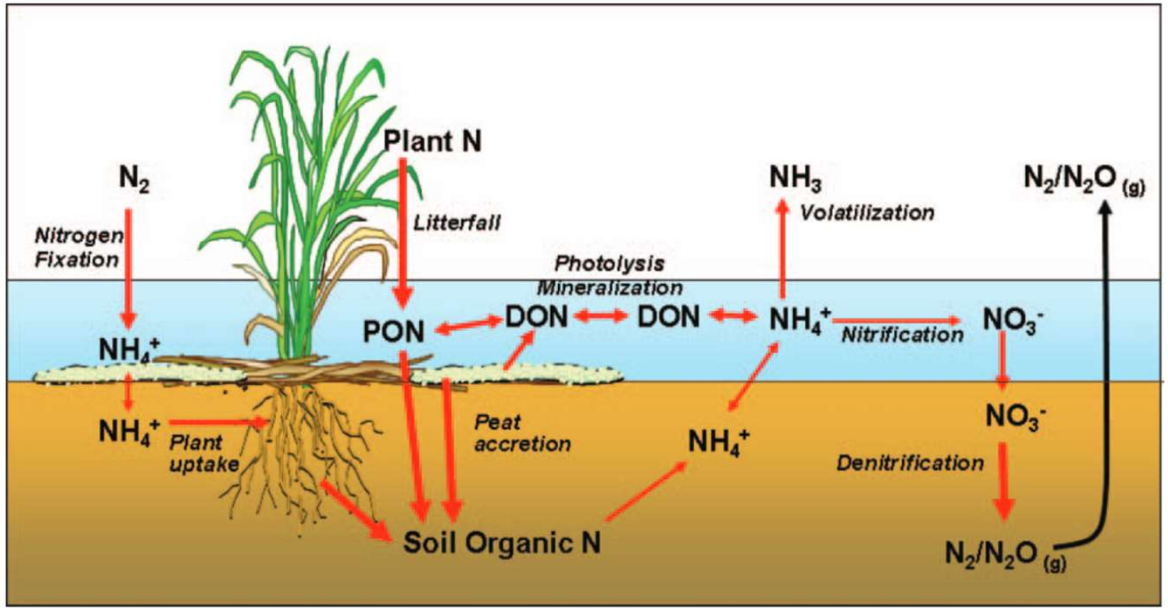




N enrichment stimulates phytoplankton production → Low dissolved oxygen → fish kills and loss of benthic communities

Increased turbidity → loss of eel grass beds

Figure reference: Inglett, P. W. , Rivera-Monroy, V. H. and Wozniak, J. R.(2011) 'Biogeochemistry of Nitrogen Across the Everglades Landscape', Critical Reviews in Environmental Science and Technology, 41: 6, 187 — 216



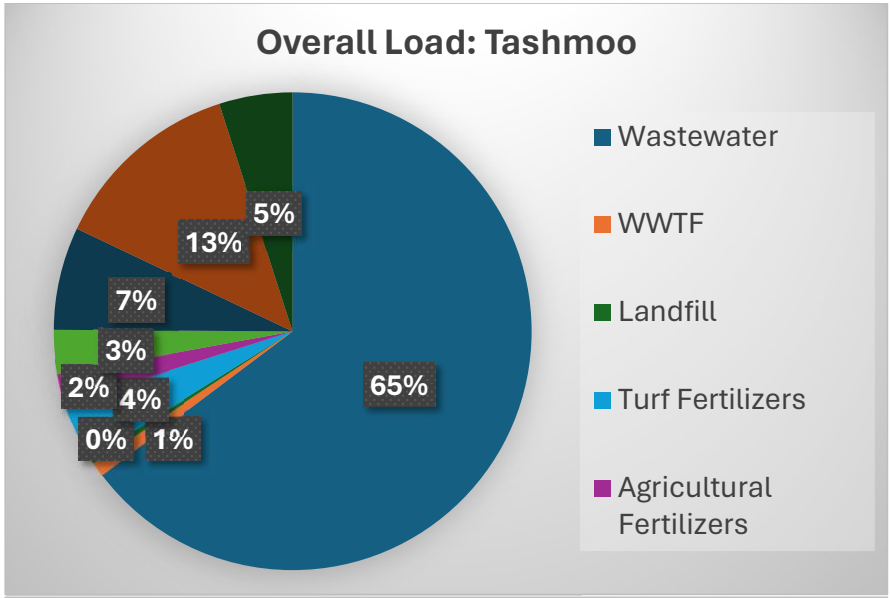
Total N

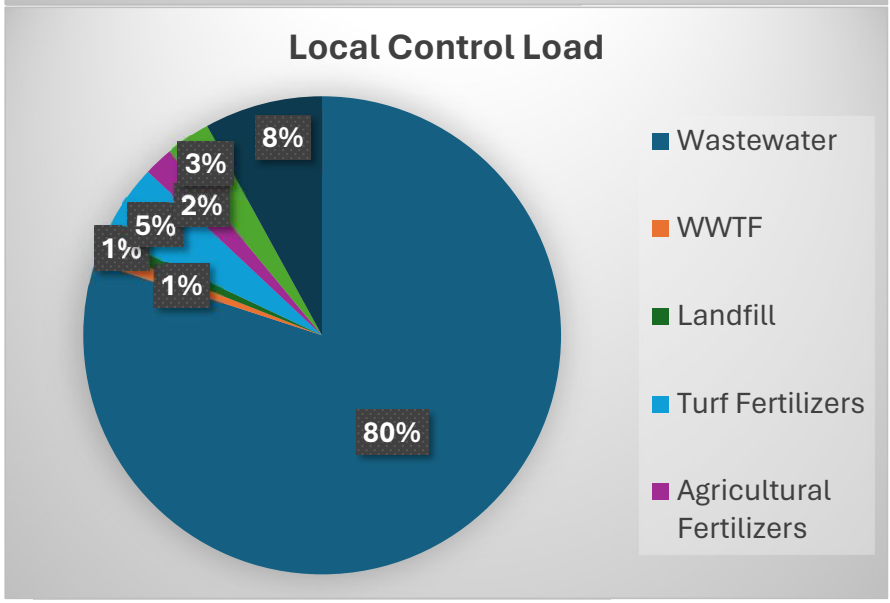
FIGURE 3. Schematic diagram of nitrogen cycle processes in wetland systems. From Reddy and DeLaune (2008). PON = particulate organic N; DON = dissolved organic N. (This figure is available in color online).

N TMDL = greatest amount of N that a waterbody can accept and still meet water quality standards for drinking, swimming, recreation, and fishing

Lake Tashmoo

- Major types of nitrogen loads:
- wastewater (e.g., septic systems),
- Tisbury WWTF discharges,
- Tisbury landfill and septage lagoon,
- turf fertilizer (including residential lawns),
- agricultural fertilizers,
- farm animals,
- impervious surfaces (including roads and roofs),
- direct atmospheric deposition to water surfaces,
- and recharge within natural areas.

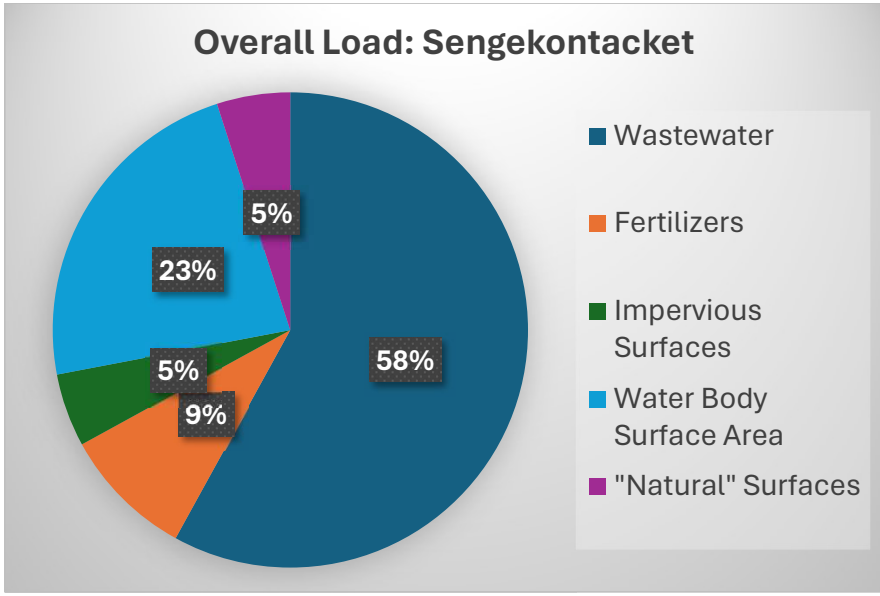


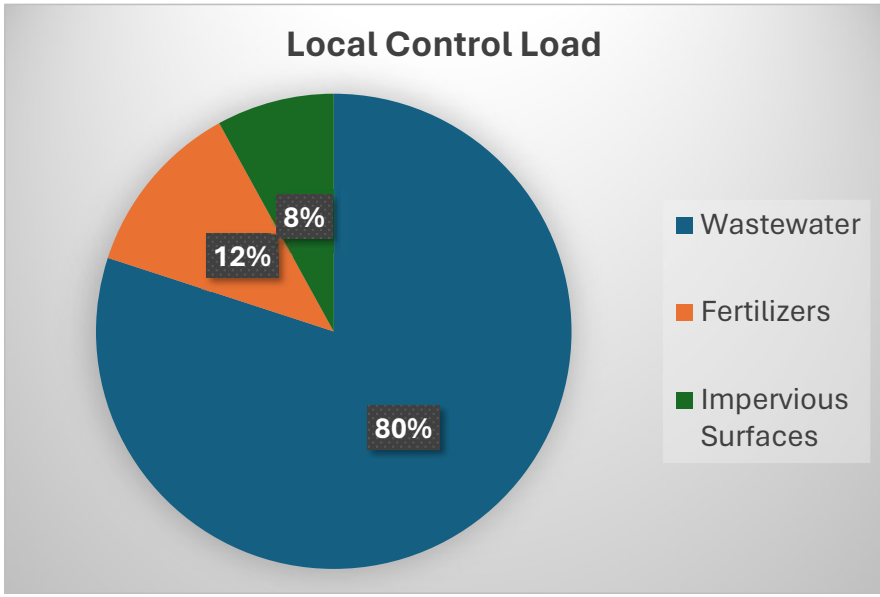


Sengekontacket Pond

Major types of nitrogen loads:

- wastewater (e.g., septic systems),
- Oak Bluffs landfill,
- fertilizer (including residential lawns and golf courses),
- impervious surfaces,
- direct atmospheric deposition to water surfaces, and
- recharge within natural areas.

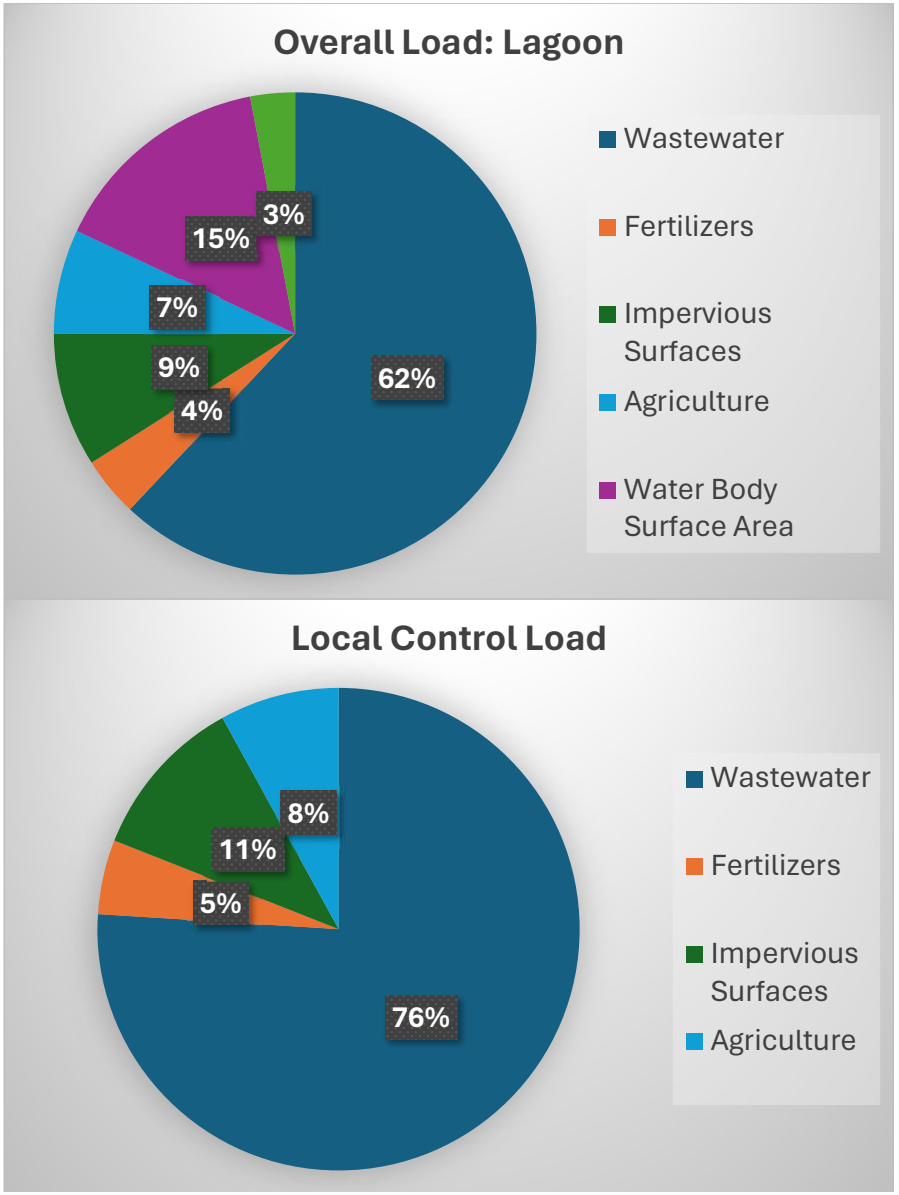




Lagoon Pond

Major types of nitrogen loads:

- wastewater (e.g., septic systems),
- residential lawn fertilizer,
- impervious surfaces,
- agriculture,
- recharge on natural areas
- direct atmospheric deposition to water surfaces,



PON isotopic signature vs MEP N load:

Wastewater derived N main contributor to primary production

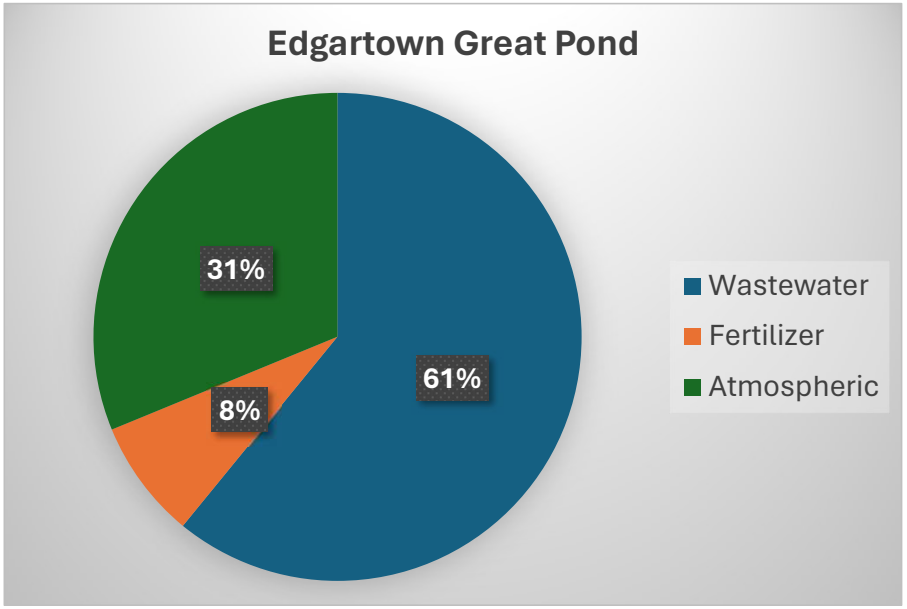
Lloret et al. (2021) PON Source Contributions

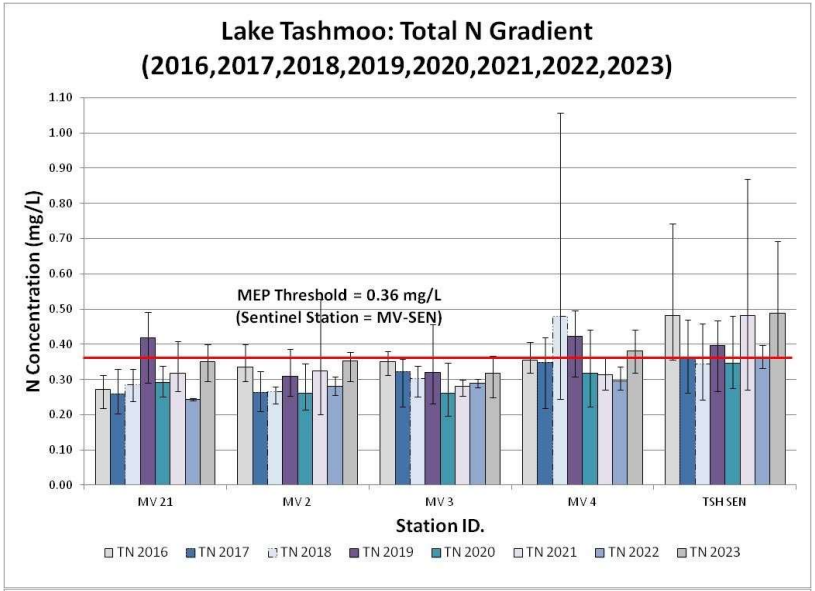
Table 2. Averages and ranges for relative contributions of wastewater, fertilizer and atmospheric nitrogen in PON samples collected in various ponds.

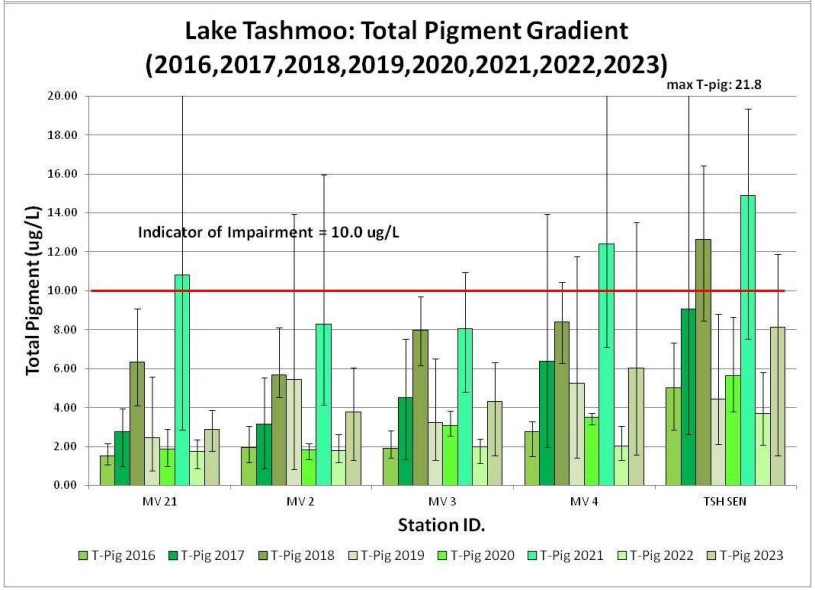
Estuary/Pond	N source	% Contribution (mean±s.d.)	Range (%)
Edgartown Great Pond	Wastewater	55±9	34-82
	Fertilizer	26±16	0-66
	Atmospheric	19±12	0-46
Crackatuxet Cove	Wastewater	51±8	32-68
	Fertilizer	28±17	0-66
	Atmospheric	21±13	0-50
Chilmark Pond	Wastewater	58±8	34-76
	Fertilizer	24±15	0-66
	Atmospheric	17±11	0-46
Tisbury Great Pond	Wastewater	53±9	30-74
	Fertilizer	27±17	0-66
	Atmospheric	20±12	0-50

Lloret J., A. Giblin, R. McHorney. Determination of the relative contribution of various sources of nitrogen to primary production in Martha's Vineyard ponds. The Ecosystems Center, Marine Biological Laboratory

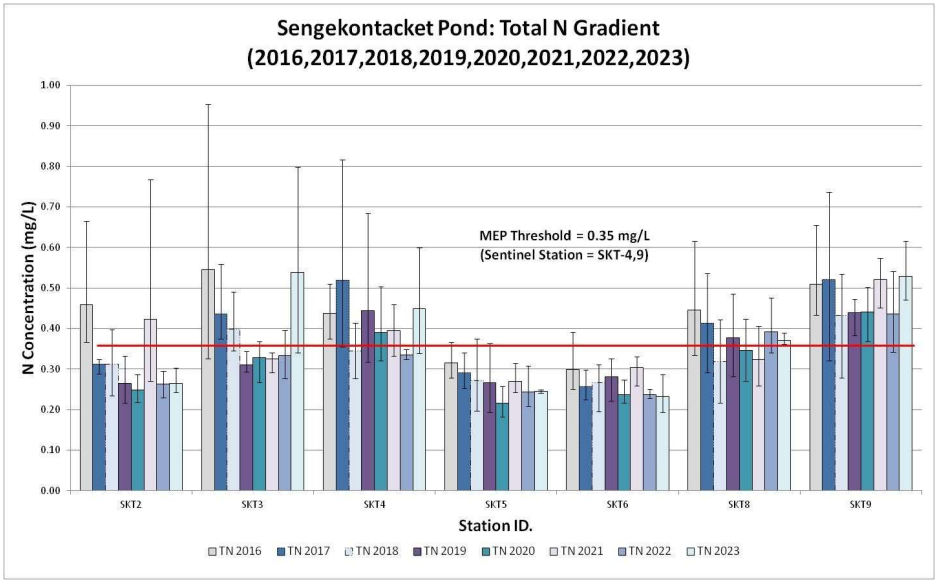
Comparable MEP N Load Contributions (2008)

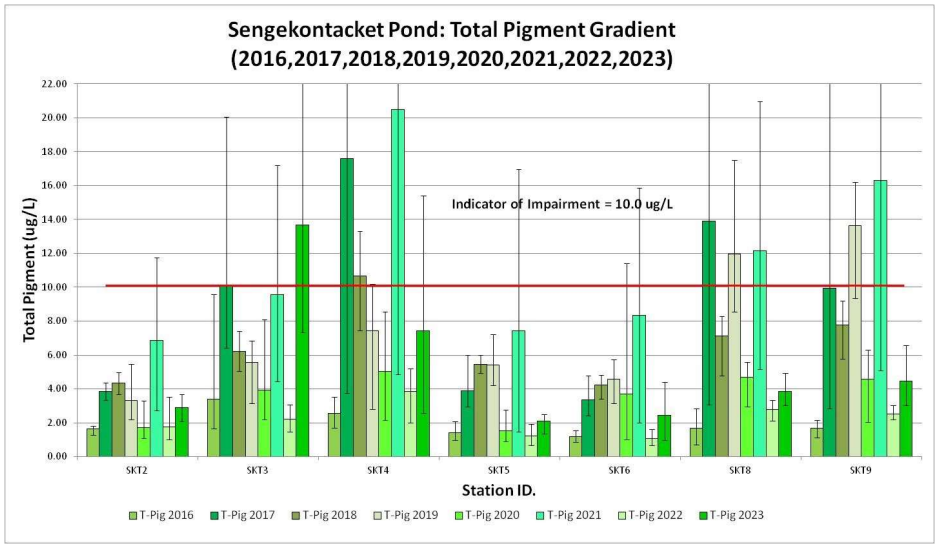




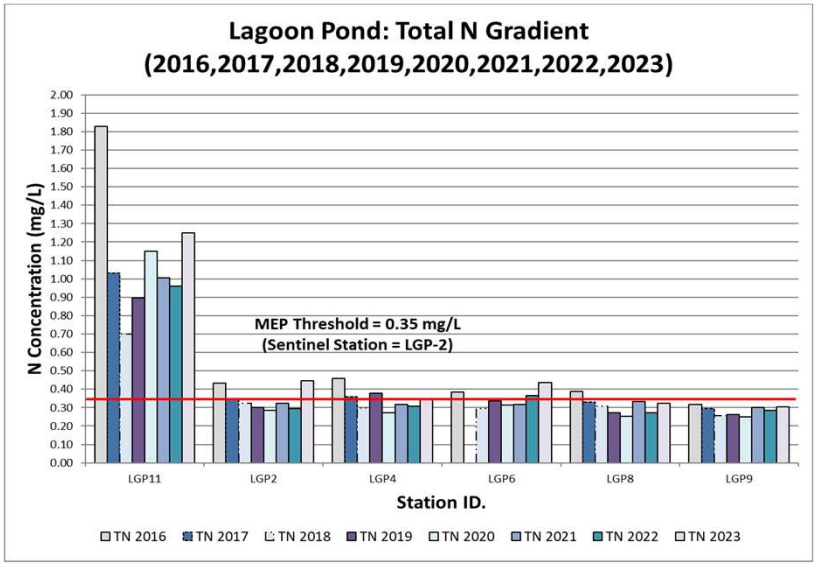


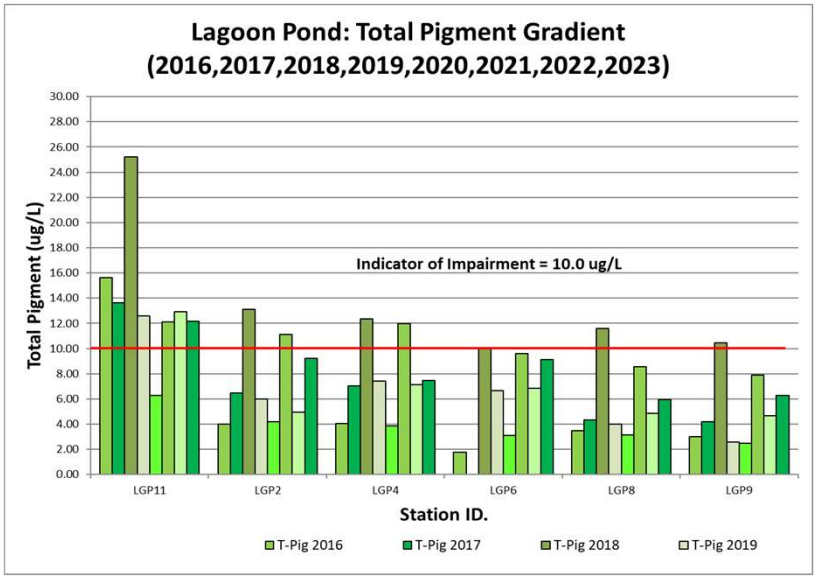
Historic Sampling Points (yellow symbols) in Lake Tashmoo including MEP established sentinel station (new station between MV4 and MV5)

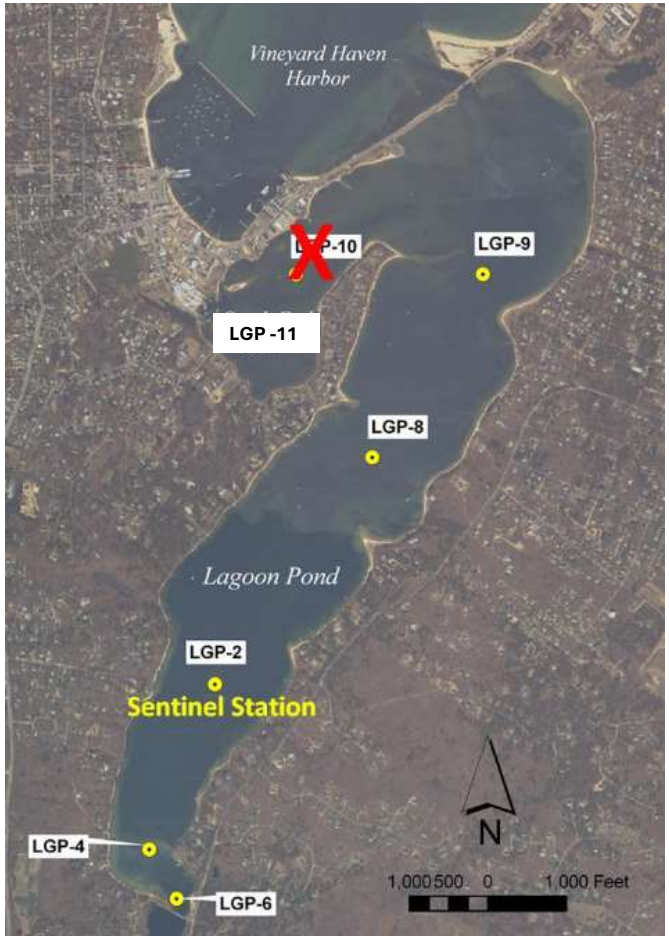




Historic Sampling Points (yellow symbols) in Sengekontacket Pond including MEP established sentinel stations STK-4 and STK-9



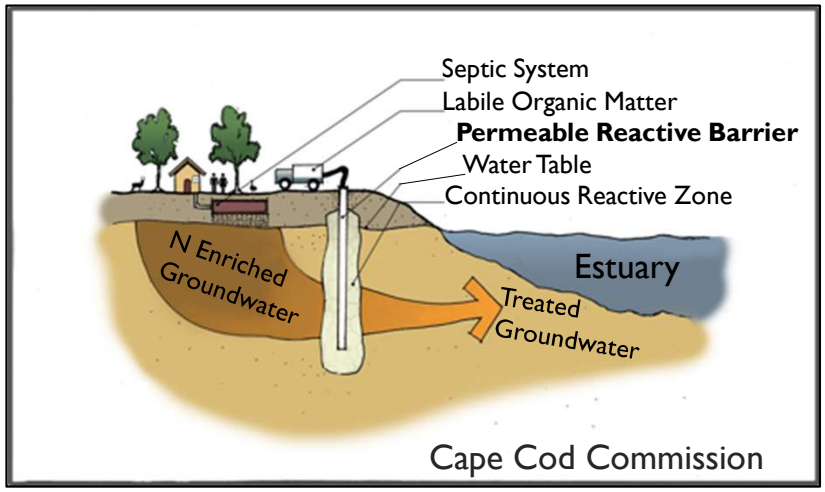




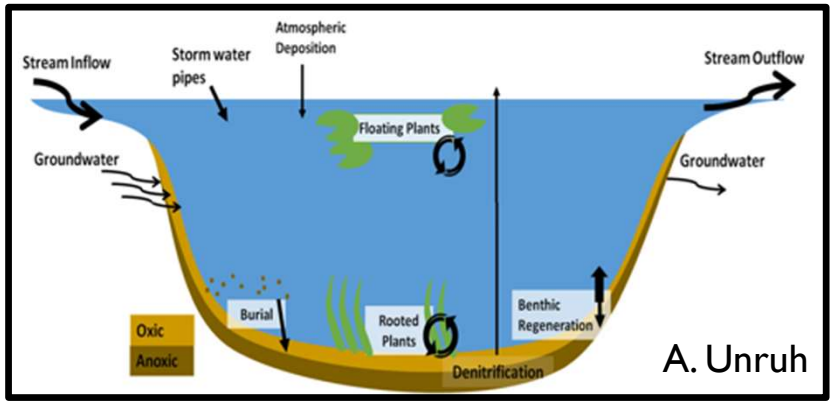
Historic Sampling Points (yellow symbols) in Lagoon Pond including MEP established sentinel station LGP-2.

Non-traditional N management technologies

1. Composting Toilet: N in composted material doesn't enter groundwater
2. Denitrifying Septic Systems promote denitrification in septic distribution field
3. PRBs promote denitrification in groundwater
4. Pond/wetland restoration
5. FTWs remove N via biological uptake and harvest
6. Oyster aquaculture

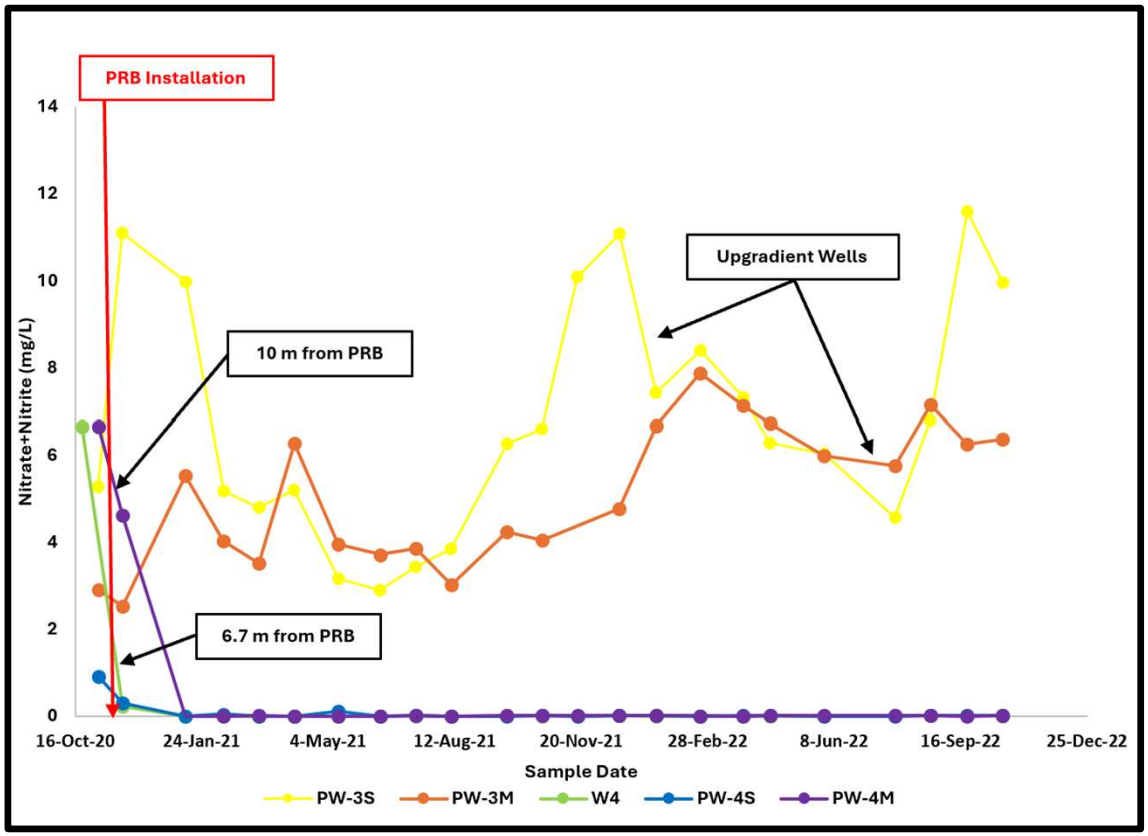


Permeable Reactive Barrier (PRB)



Freshwater Pond restoration

Lagoon Pond Road Permeable Reactive Barrier



Winter

Depth (m)	Upgradient Concentration (mg/L)	Downgradient Concentration (mg/L)	% Reduction Nitrate+Nitrite	Kg NOx Removed / day
2	8.18	0.04	-99.5%	-0.07
4.5	5.73	0.05	-99.1%	-0.06
7.5	3.90	0.01	-99.7%	-0.04
Total	5.97	0.04	-99.3%	-0.16

Summer

Depth (m)	Upgradient Concentration (mg/L)	Downgradient Concentration (mg/L)	% Reduction Nitrate+Nitrite	Kg NOx Removed / day
2	7.23	0.04	-99.4%	-0.04
4.5	5.52	0.19	-96.6%	-0.05
7.5	4.09	0.01	-99.8%	-0.02
Total	5.61	0.12	-97.9%	-0.11

Next steps…

- Continued water quality to track long-term trends
- Conduct updated benthic and eel grass surveys to compare to baseline MEP