Impacts of **Invasive-Plant Management** on **Nitrogen-Removal Services** in Freshwater Tidal Marshes of the Hudson River

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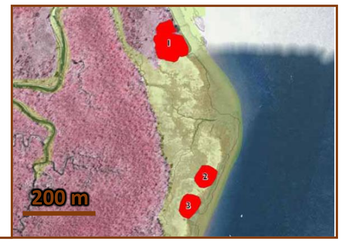
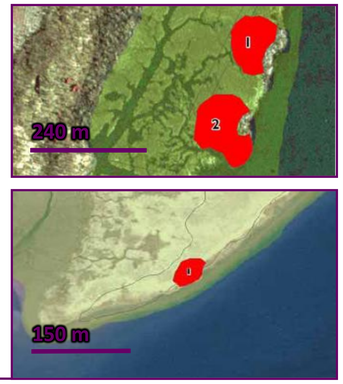
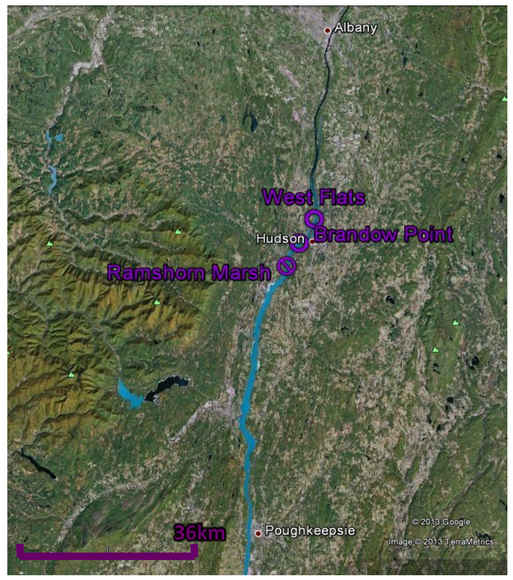
The Nature Conservancy removed three replicate patches of *Phragmites australis* (<2 acres each) from **Ramshorn Marsh** in September 2011 using glyphosate herbicide. These patches were monitored August 2009–September 2012.



Three replicate *Phragmites* patches, two located at **West Flats** (top), and one at **Brandow Point** (below), were monitored as reference sites August 2010—September 2012. Beginning September 2011, paired sites dominated by *Typha angustifolia* were sampled at all treatment and reference locations. Organic matter, ammonium (NH_4), nitrate (NO_3), and denitrification potential were measured 2009-2012. Aboveground plant biomass and leaf C:N were also measured 2011-2012.



Patch maps from Zimmerman, C. and R. Shirer. 2009. Hudson River Invasive Plant Pre-Treatment Monitoring Report. The Nature Conservancy. Albany, NY, USA.



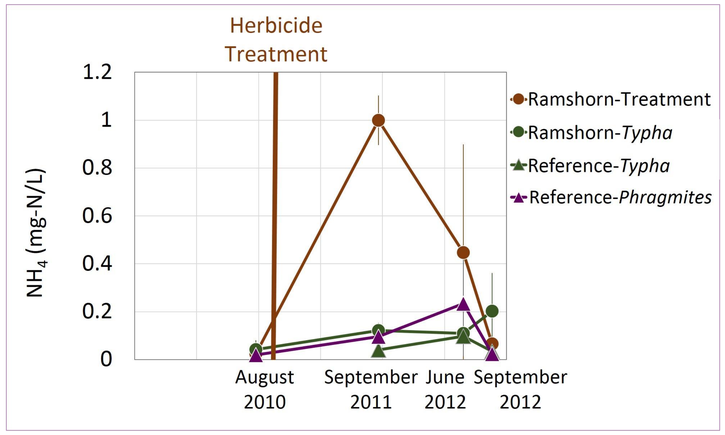
Ramshorn *Phragmites* Patch 2 – August 2010

Ramshorn Patch 2 after Treatment – September 2011

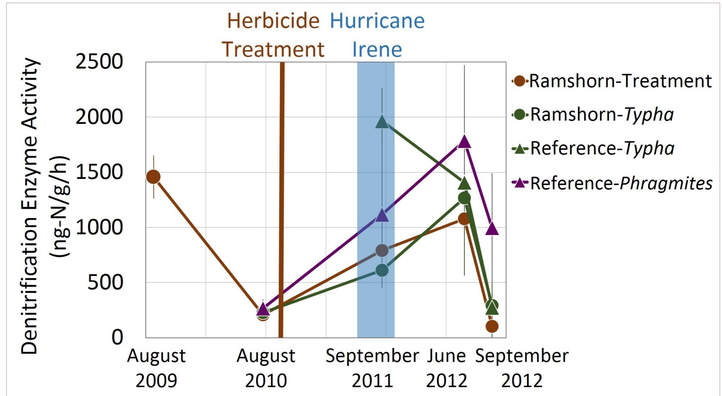
Ramshorn Patch 1 September 2011

Ramshorn Patch 1 September 2012

Ramshorn Patch 2 after Treatment – June 2012

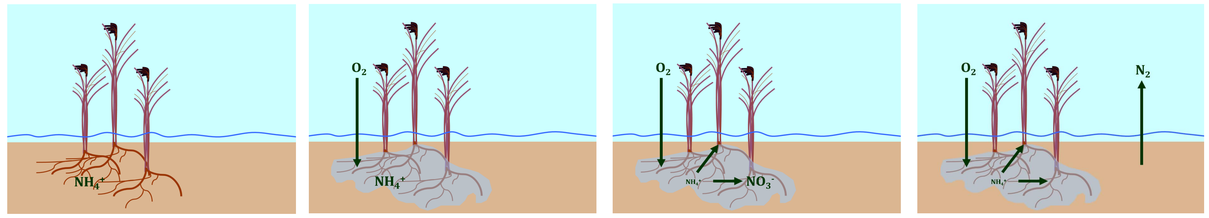


Sediment ammonium (NH_4) concentrations increased by an order of magnitude following *Phragmites* removal, relative to all vegetated sites. This effect diminished over time.

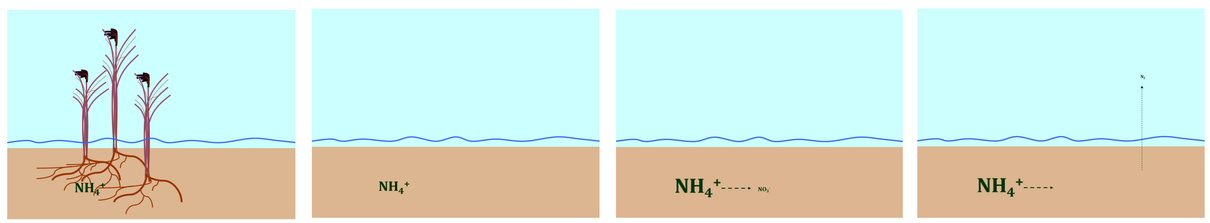


Denitrification potentials (DEAs) were lower in removal sites than in sites dominated by *Phragmites*. This trend persisted for at least two years post-removal. With the exception of measurements conducted following Hurricane Irene, DEAs were consistently highest in *Phragmites*-dominated sediments. DEA measurements varied significantly across sampling times.

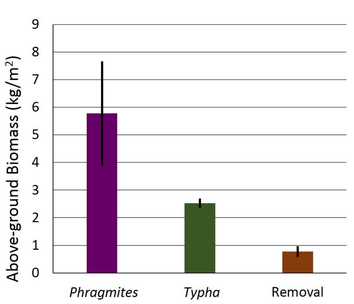
What effect will small scale ***Phragmites australis*** removals have on **sediment nutrients** and **denitrification**?

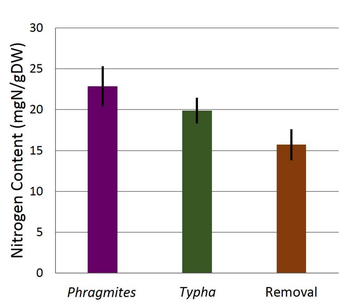


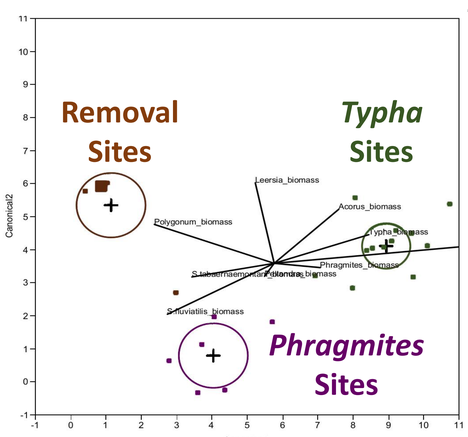
Hypothesized Mechanism: *Phragmites australis* and other plants transfer oxygen to sediments, facilitating nitrification (oxidation of NH_4 to NO_3) and denitrification (reduction of NO_3 to N_2 gas).



Predictions: Following removal, less oxygen will be available, and uptake of NH_4 by plants will cease. Ammonium (NH_4) concentrations should increase, and denitrification rates should decrease due to nitrate (NO_3) limitation. These effects should diminish as native plants recolonize removal sites.







Two years following removal, treated sites in Ramshorn Marsh were recolonized by distinct plant communities with **low biomass** and **low nitrogen content**, relative to communities dominated by *Phragmites australis* or *Typha angustifolia*. The most common species found in removal sites included *Leersia oryzoides*, *Polygonum arifolium*, *Peltandra virginica*, *Impatiens capensis*, *Scirpus fluviatilis*, and *Scirpus tabernaemontani*.

Summary Results of ***Phragmites australis*** removals

1. Removal of *Phragmites* significantly **increased ammonium concentrations** in sediments, but this effect was temporary.
2. Removal sites were recolonized by a **low-biomass plant community**, dominated by *Leersia oryzoides*, *Polygonum arifolium*, *Peltandra virginica*, *Impatiens capensis*, *Scirpus fluviatilis*, and *Scirpus tabernaemontani*.
3. In removal stands, **denitrification was consistently lower** than in *Phragmites*-dominated stands. This result has persisted for two growing seasons.
4. In the future, we may need to consider **possible trade-offs** between invasive-species management and nitrogen-removal services.
5. We detected considerable **interannual and interseasonal variation in denitrification**, highlighting a need for more frequent intra- and interannual monitoring efforts in order to fully understand the dynamics of plant-sediment interactions, and their impacts on nitrogen cycling.

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