

▶▶▶ SUBGROUP SPOTLIGHT

The Nitrogen group is examining oil spill impacts on benthic nitrogen cycling. The nitrogen cycle is made up of several processes including nitrogen fixation, nitrification and denitrification, which convert nitrogen from one form to another through both physical and biological processes (many of these conversions are done by microbes). The Nitrogen group is focusing on how oil impacts the process of *denitrification* in salt marshes and unvegetated sediment. They have hypothesized that denitrification capacity is higher on the marsh surface compared to the subtidal unvegetated sediments not because there are vast differences in what microbes are present (functional microbial community structure) but because there is more raw material present.

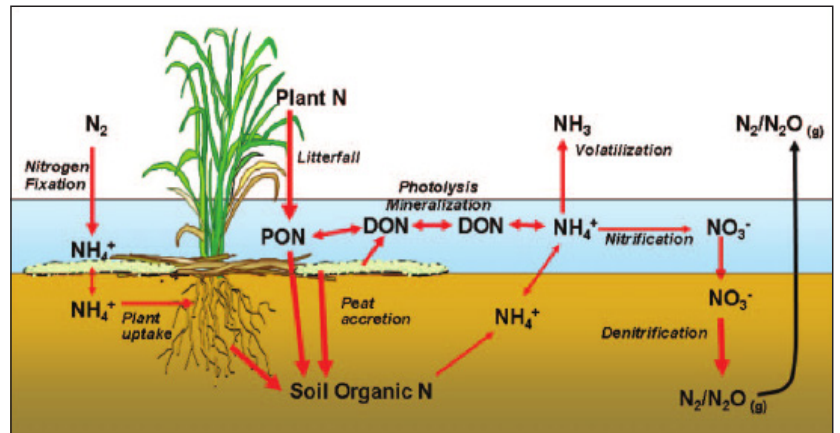
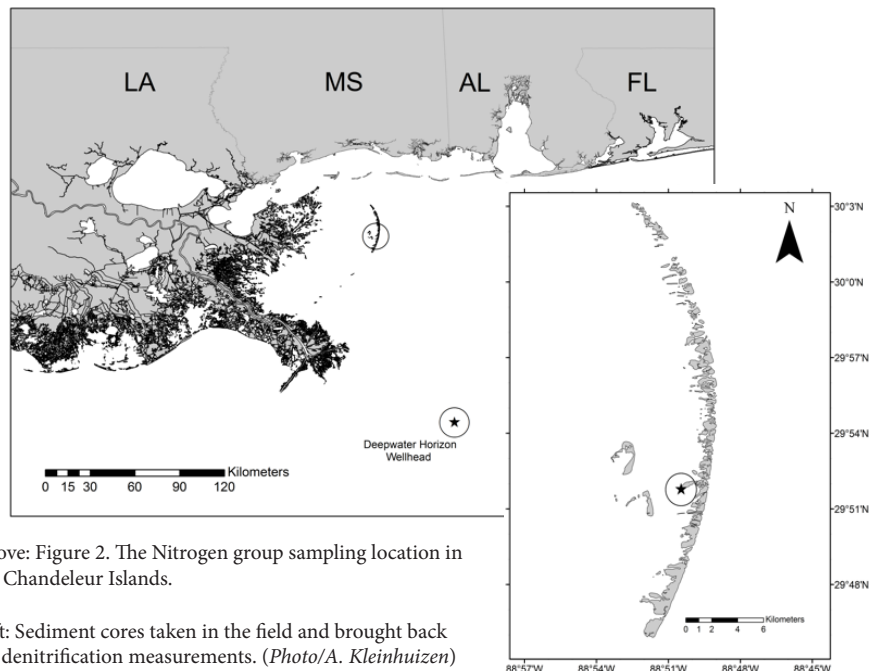
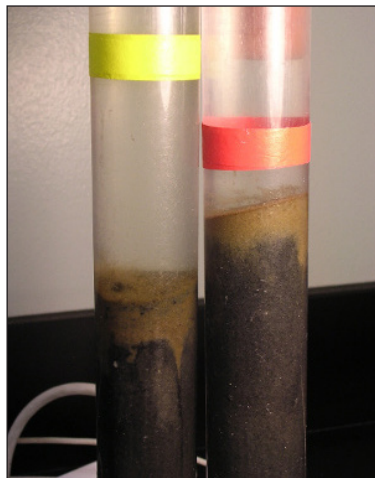


Figure 1. Nitrogen cycle in a coastal wetland.

Source: Reddy, K.R. and R.D. Delaune. 2008. Biogeochemistry of Wetlands: Science and Applications. CRC Press, Boca Raton, FL.

Field Investigations: Sediment cores were collected in the Chandeleur Islands at 3 sites that experienced either heavy, moderate or no oiling. At the least impacted site, five replicate sediment cores for each site were collected from both salt marsh and unvegetated sediment on a seasonal basis during a year. Denitrification rates, sediment porewater geochemistry and microbial community structure and function were investigated. Denitrification rates were measured with the *isotope pairing technique*. Microbial functional groups were identified using *functional marker genes*. For these experiments the Nitrogen group measured the specific marker genes for the enzymes that catalyze specific transformations in the nitrogen cycle.

Laboratory manipulations: Mesocosm experiments were conducted in 2016 in collaboration with the Wetlands group. Sediment cores were collected from *Spartina alterniflora* monoculture and polyculture plant treatments with and without oil at month 6 and 11 of the experiment. Core samples were analyzed for denitrification and nitrogen fixation rates and the *shotgun sequencing* analysis.



Above: Figure 2. The Nitrogen group sampling location in the Chandeleur Islands.

Left: Sediment cores taken in the field and brought back for denitrification measurements. (Photo/A. Kleinhuizen)

Results to date

The Nitrogen group has collected over 120 cores at multiple locations in the Chandeleur Islands from the marsh surface to the unvegetated subtidal sediments at the marsh edge. The unvegetated subtidal sediments at the marsh edge were found to have characteristics similar to that of a marsh edge that had been eroded and subsequent vegetation loss. To date, results have shown that denitrification rates on the marsh surface were similar to those measured elsewhere in Louisiana prior to the DWH spill.

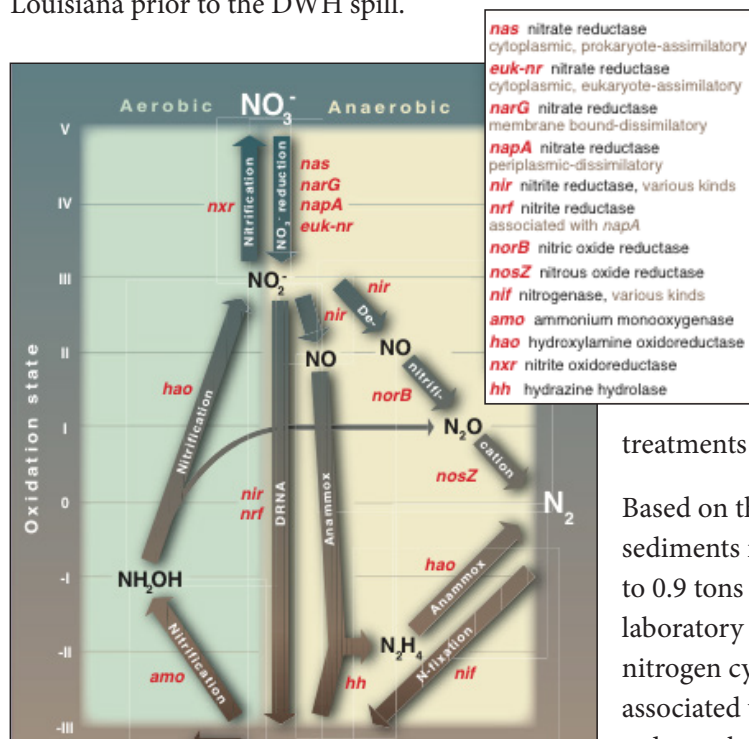


Figure 3. The major transformations of the nitrogen (arrows) and the enzymes (red) that catalyze them. The genetic analysis investigated the abundance of genes for these enzymes.

Source: D. E. Canfield, A. N. Glazer and P. G. Falkowski, The evolution and future of earth's nitrogen cycle. Science. 2010, 330, 192-196

KEY WORDS

denitrification - the conversion of nitrate (NO_3^-) to nitrogen gas by chemical reduction; carried out by microbial organisms in the sediment

functional marker genes - a gene that is directly linked to a specific biogeochemical function

Isotope Pairing Technique (IPT) - one of the techniques commonly used to measure denitrification; based on tracing the conversion of added ^{15}N , a stable isotope

shotgun sequencing - a method of sequencing long DNA strands by shredding or "shotgunning" DNA into smaller fragments, which are then sequenced individually

However, denitrification capacity in marsh sediments was, on average, four times higher than in subtidal sediments. Analysis of genes for denitrification indicated that the amount of marsh vegetation regulates the activity, rather than the abundance, of the microbial communities carrying out denitrification. Data from the laboratory manipulations six months post oiling suggest rates of nitrogen fixation increased significantly, while denitrification declined precipitously in the oiled treatments. Surprisingly, differences between the rates of nitrification and denitrification in the oiled and control treatments were no longer different eleven months post oiling.

Based on these results, the Nitrogen group has calculated that marsh sediments remove an average of 3.6 tons of nitrogen $\text{km}^{-2}\text{yr}^{-1}$ compared to 0.9 tons of nitrogen $\text{km}^{-2}\text{yr}^{-1}$ by unvegetated sediments. The laboratory manipulations suggest that many of the changes in the nitrogen cycle following oiling are transient. However, marsh collapse associated with oil spill induced erosion of marshes significantly reduces the ecosystem denitrification capacity and the ability of coastal regions to remove excess nitrogen from the environment.

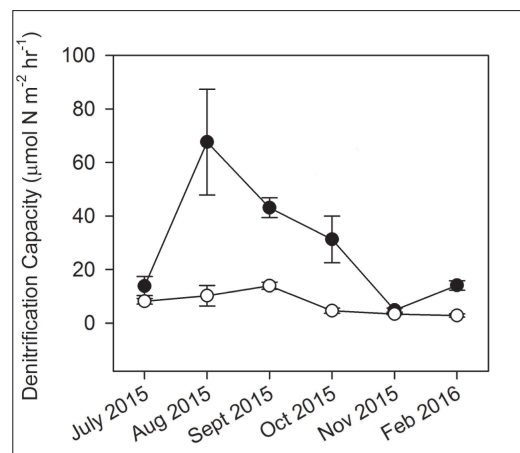


Figure 4. Denitrification capacity in marsh sediments (closed circles) and subtidal unvegetated sediments (open circles) in the Chandeleur Islands.

ABOUT US

The Alabama Center for Ecological Resilience (ACER) Consortium investigates how biodiversity influences an ecosystem's ability to resist and recover from disturbance, focusing on impacts of the 2010 Deepwater Horizon oil spill on coastal ecosystems in the northern Gulf of Mexico.

This publication was made possible by grant number GoMRI231504-00 from the Gulf of Mexico Research Initiative.



Project Contact Information

<http://acer.disl.org/>

acer@disl.org

Dauphin Island Sea Lab

101 Bienville Blvd,

Dauphin Island, AL 36528

