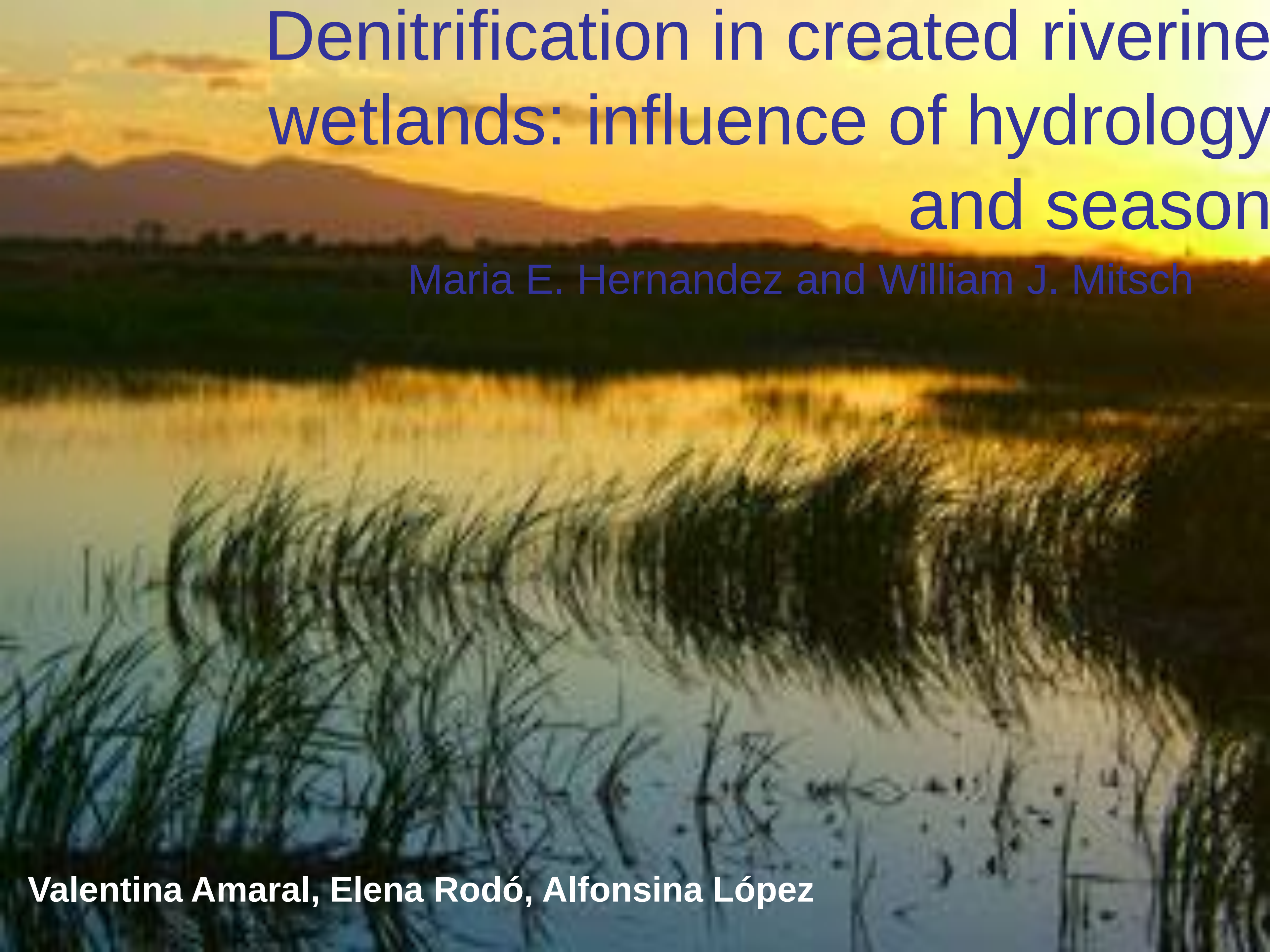

Denitrification in created riverine wetlands: influence of hydrology and season

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Introduction

- Agricultural runoff is a main source of nitrogen loading in the Mississippi river.
- Creation and restoration wetlands has been recommended.
- Permanent nitrogen removal occurs via denitrification .

Denitrification

- The reduction of NO_3^- to nitrogen gaseous form (N_2O,N_2)

- Carried out by anaerobic facultative bacteria in anoxic conditions

- Flood pulses also nutrient pulse changing oxygen availability of soilsand the potential area of denitrification

Hipothesis

1. Denitrification rates would be higher in high marsh zones that have an intermittent flood frequency than in low marsh and edge zones that were permanently flooded or mostly dry, respectively
2. Denitrification rates would be higher in zones near the inflow than near the outflow of wetlands
3. Denitrification rates would have seasonal variations due to changes in soil temperature and nitrate availability and therefore we expected highest denitrification rates in spring and summer.

Objectives

- Investigate seasonal denitrification rates in zones in longitudinal and transverse gradients in two similar 1-ha created wetlands in the Midwestern USA under both pulsing and steady-flow conditions, and to assess the controlling factors of denitrification in these zones.

Material and Methods

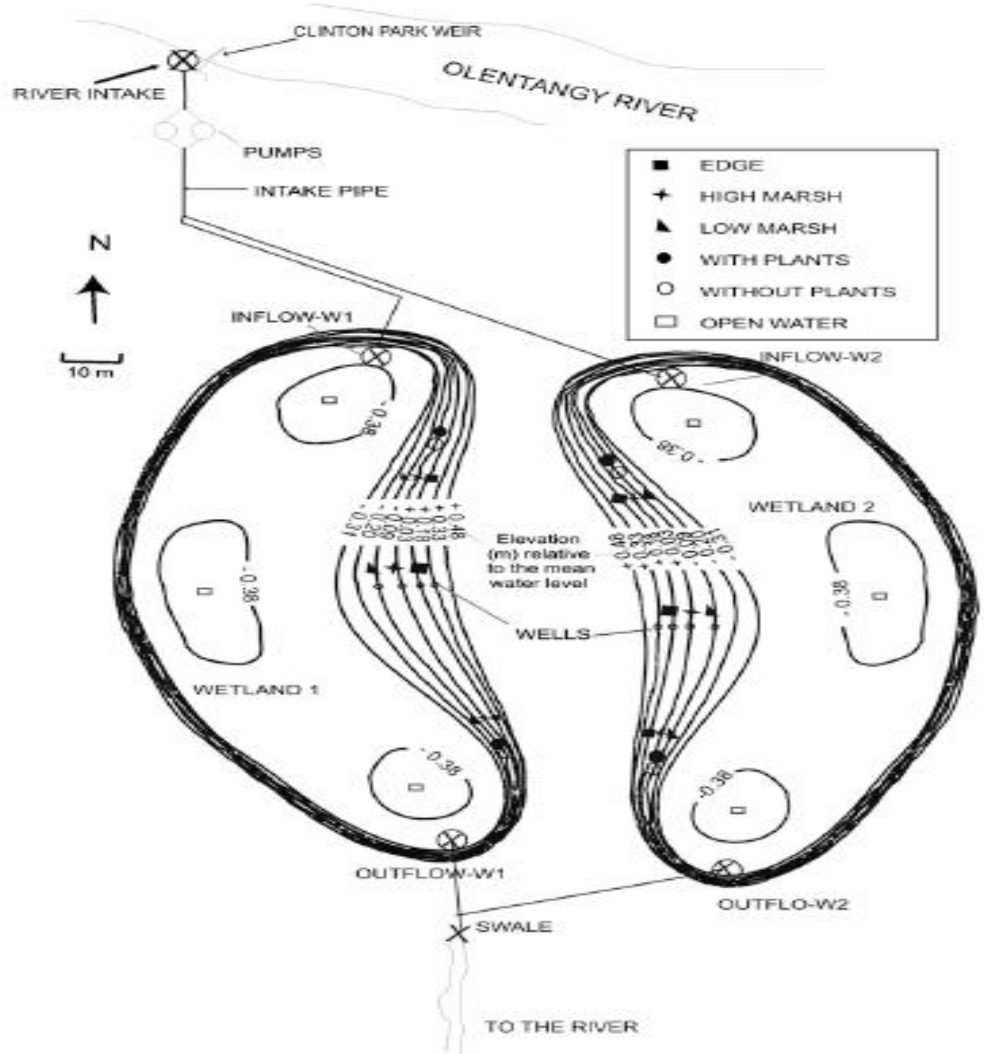


Fig. 1 – Two 1-ha experimental wetlands at Olentangy River Wetlands Research Park (ORWRP), The Ohio State University, Columbus, USA, used in this study. Sample locations on gradients on inside of kidney-shaped wetlands are indicated. Circular and oval areas in each wetland are deepwater basins. Contours are shown in meters above mean water level.

- Study was carried on in a pair of 1 ha river diversion experimental wetlands adjacent to Olentangy River.
- Soil type: floodplain alluvial soil
- Wetlands were treated as replicates, receiving same amount of water under two different hydrologic conditions: **pulsing and steady flow**
- Seasonal hydrologic pulses were simulated by pumping river water at high rates during the 1st week of each month in 2004

Carbon or Nitogen as controlling factors:

✓soil cores

✓4 treatements: Distilled water

Nitrogen (KNO_3)

Carbon (glucose)

C+N

Analythical methods:

✓N_2O: gas chromatograph

✓Denitrification rates measured :

field (linear nitrous oxide production in acetylene presence)

incubations (N_2O production vs. sampling time)

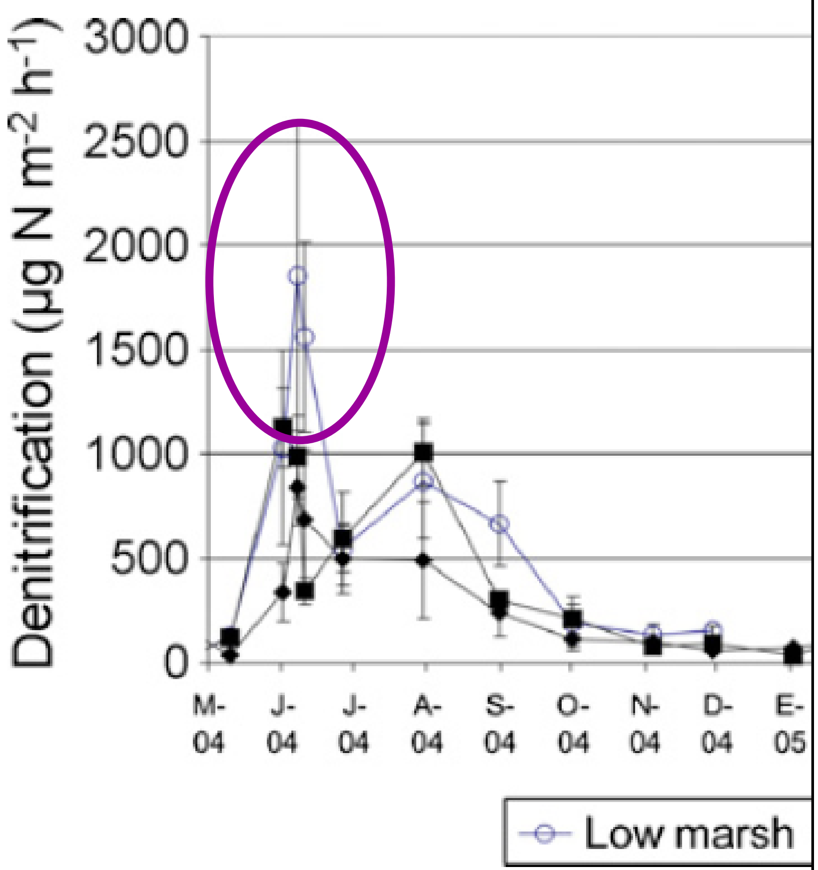
Strong Factors

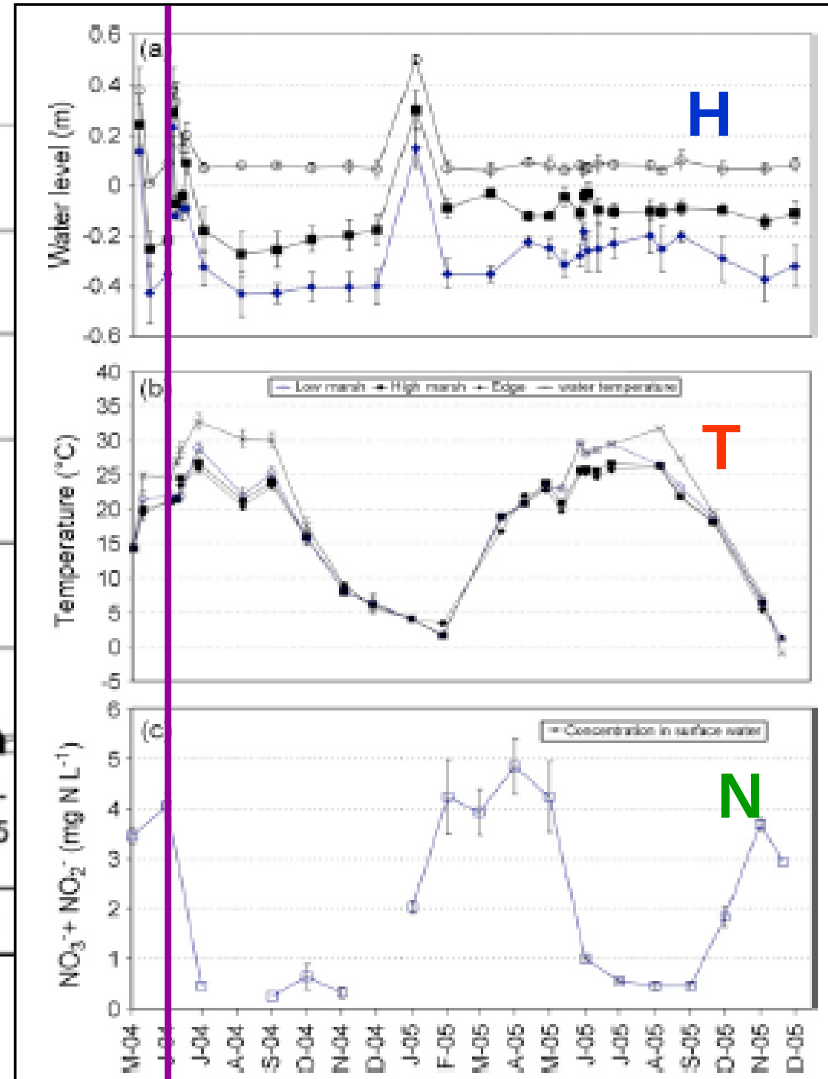
Denitrification

- ✓**Hydrologic conditions H**
- ✓**Soil temperature S**
- ✓**Nitrate concentration N**

Results

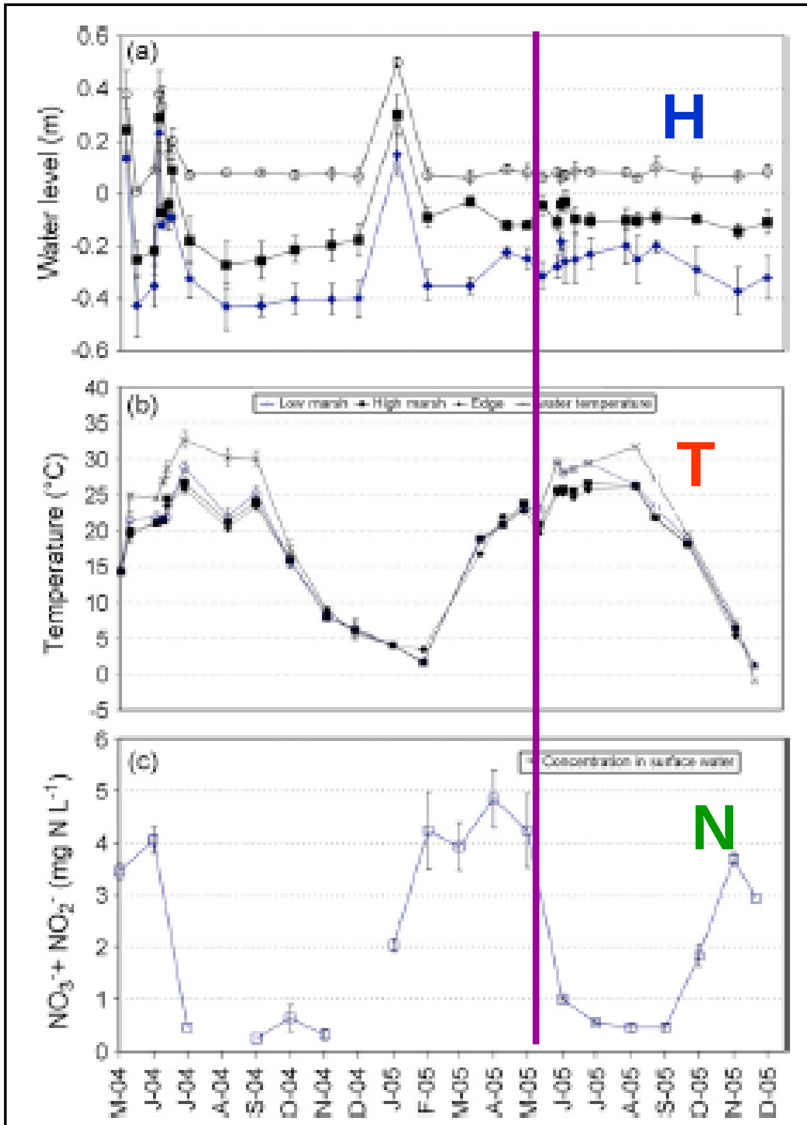
Low marsh

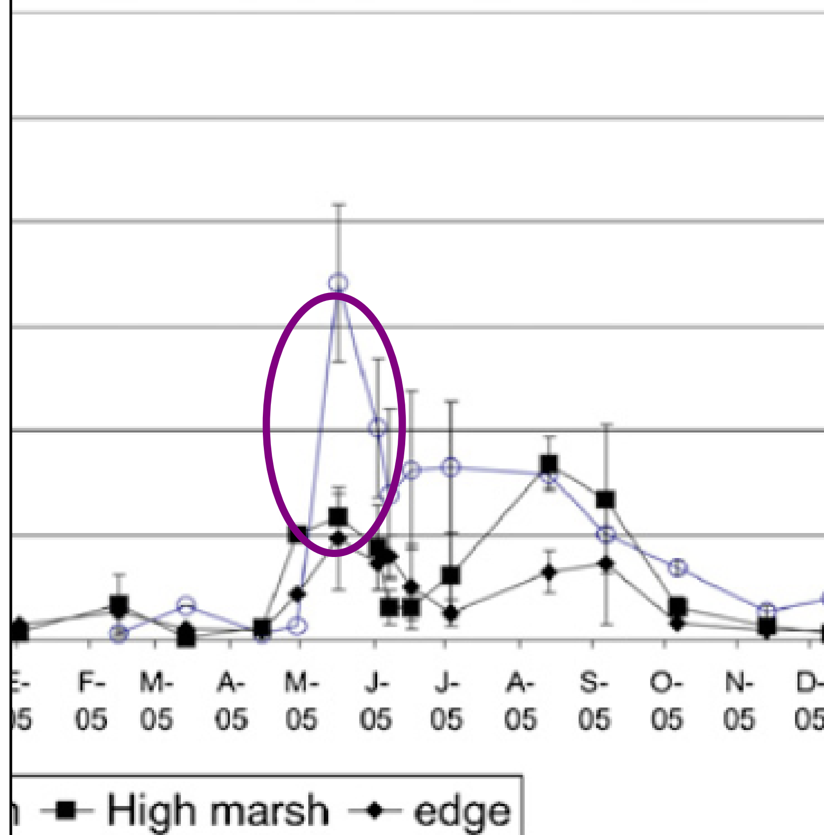




Results

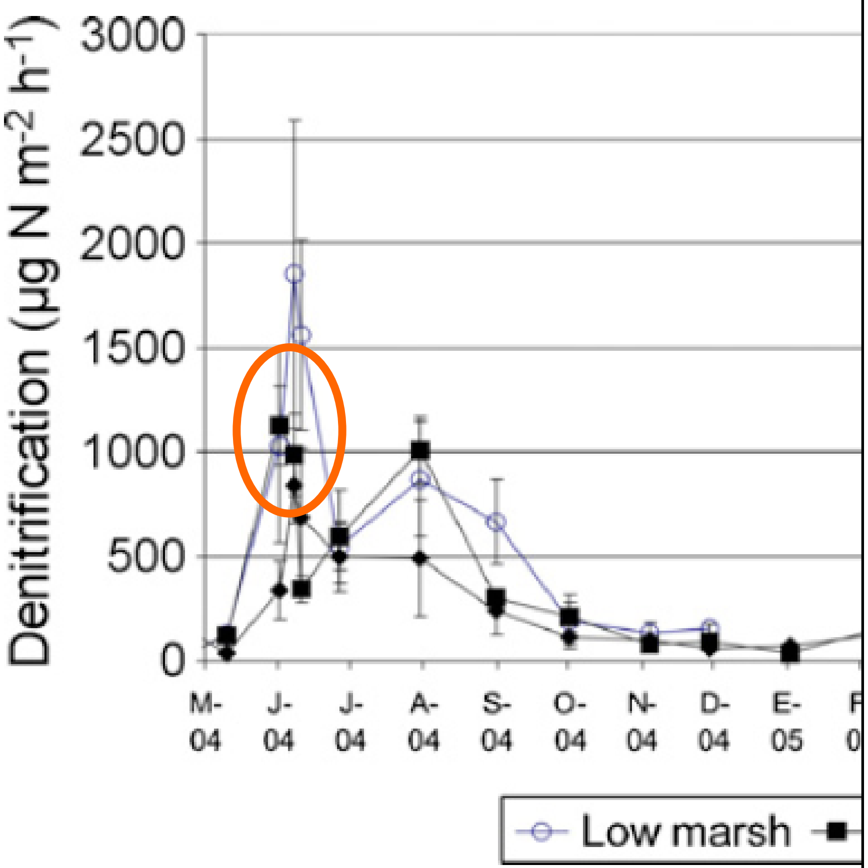
Low marsh

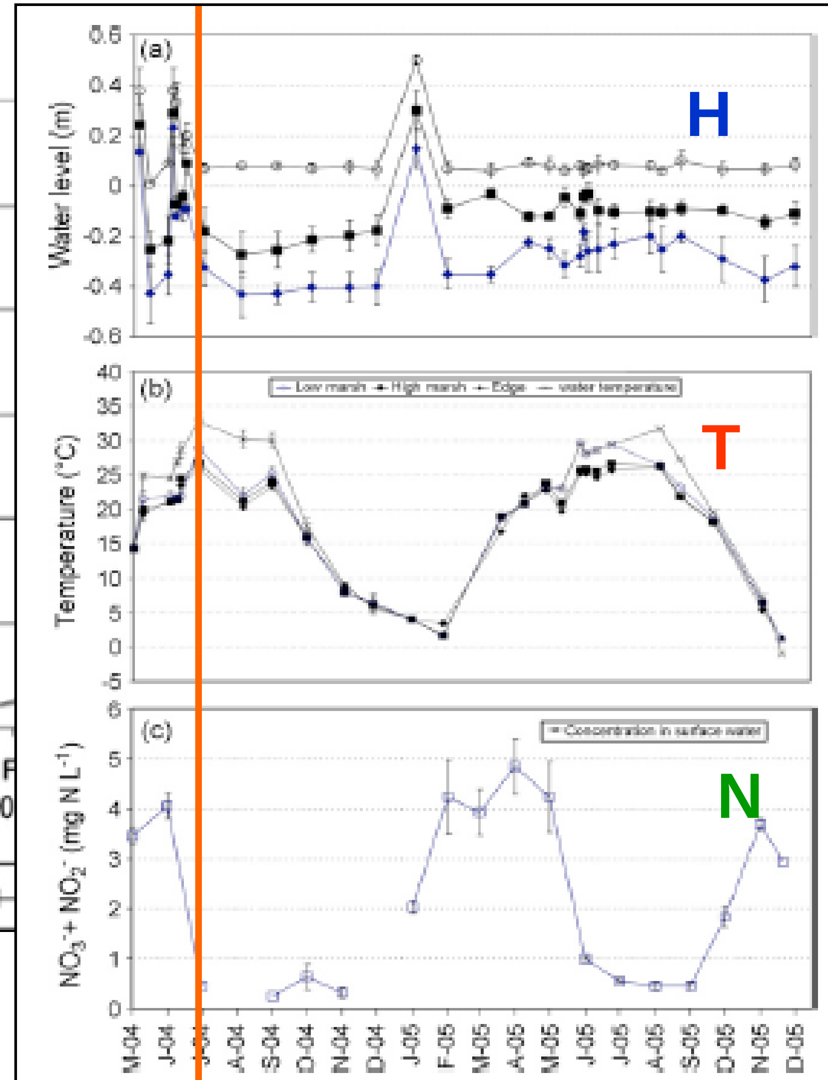




Results

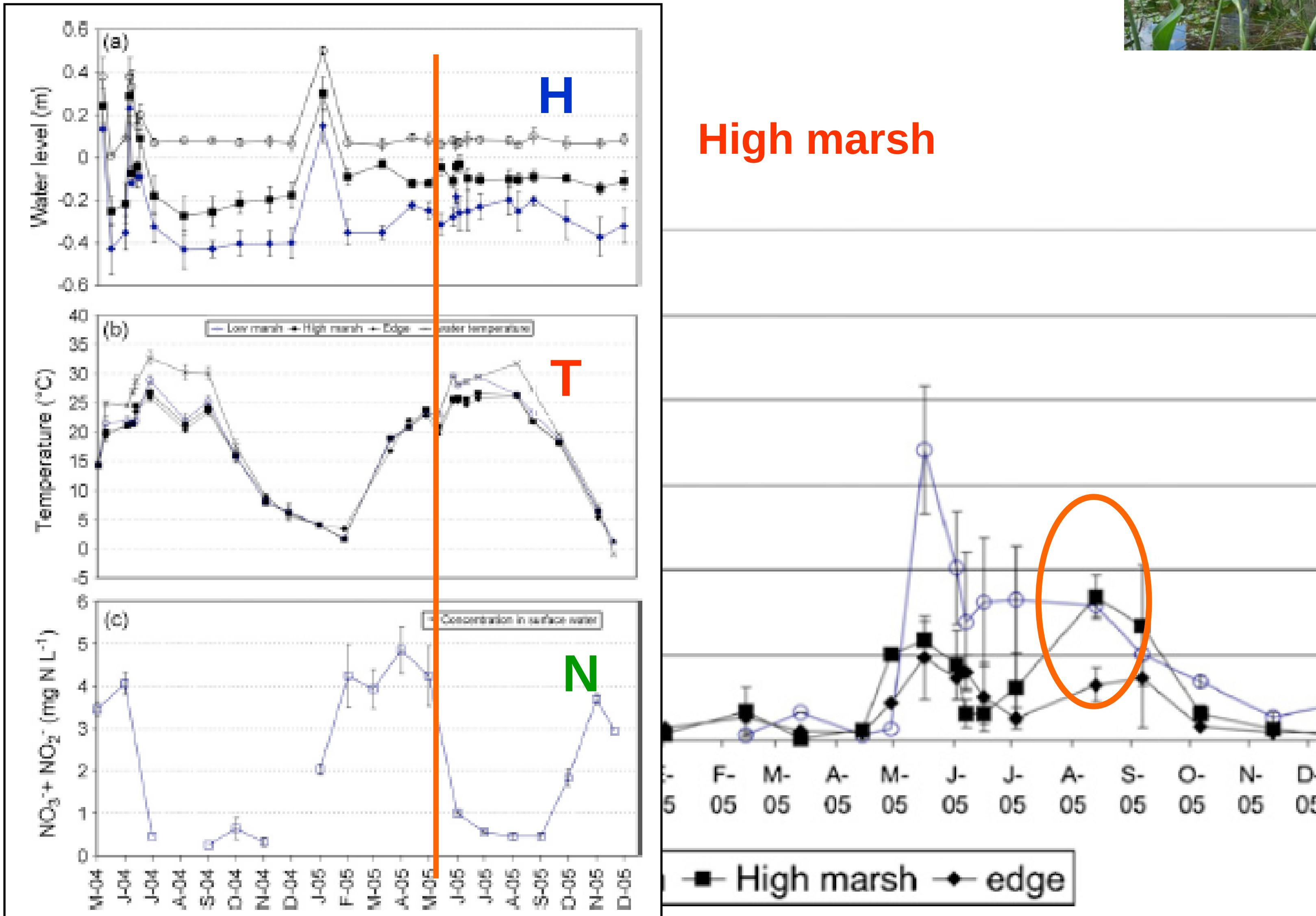
High marsh





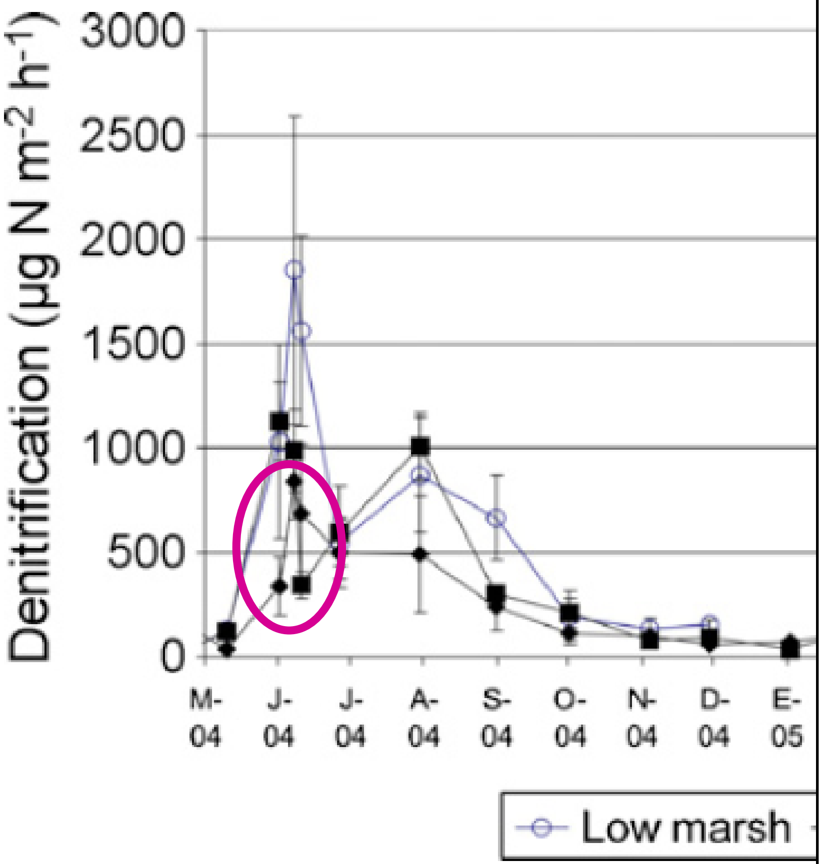
Results

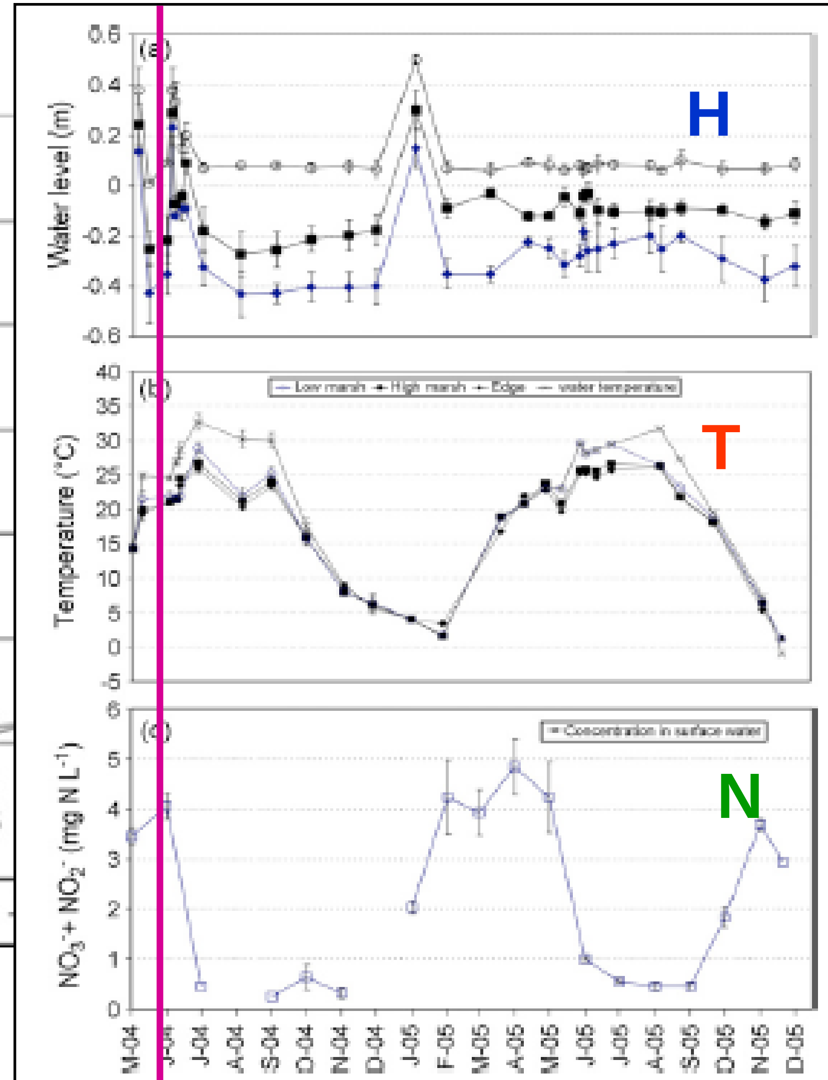
High marsh



Results

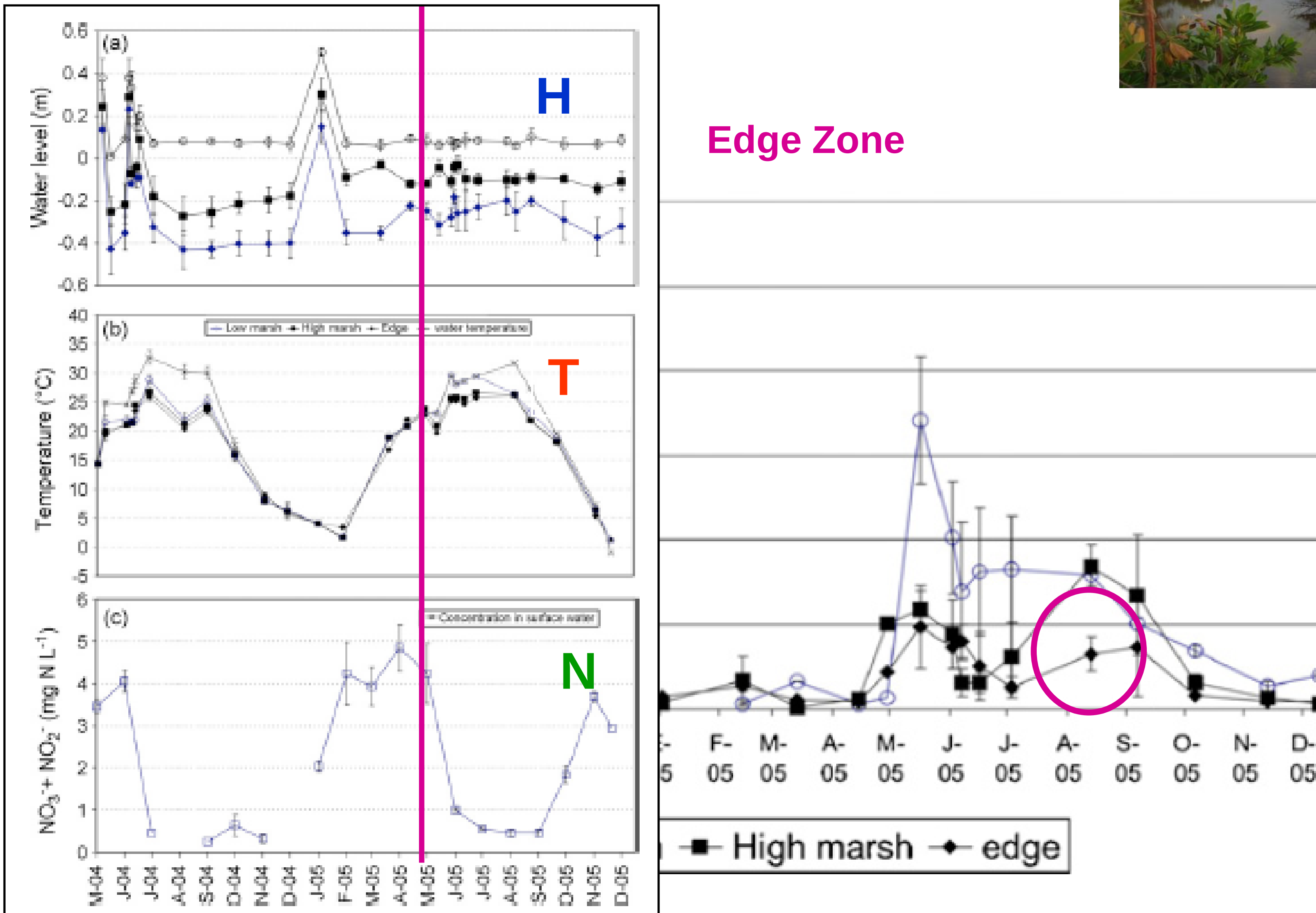
Edge Zone



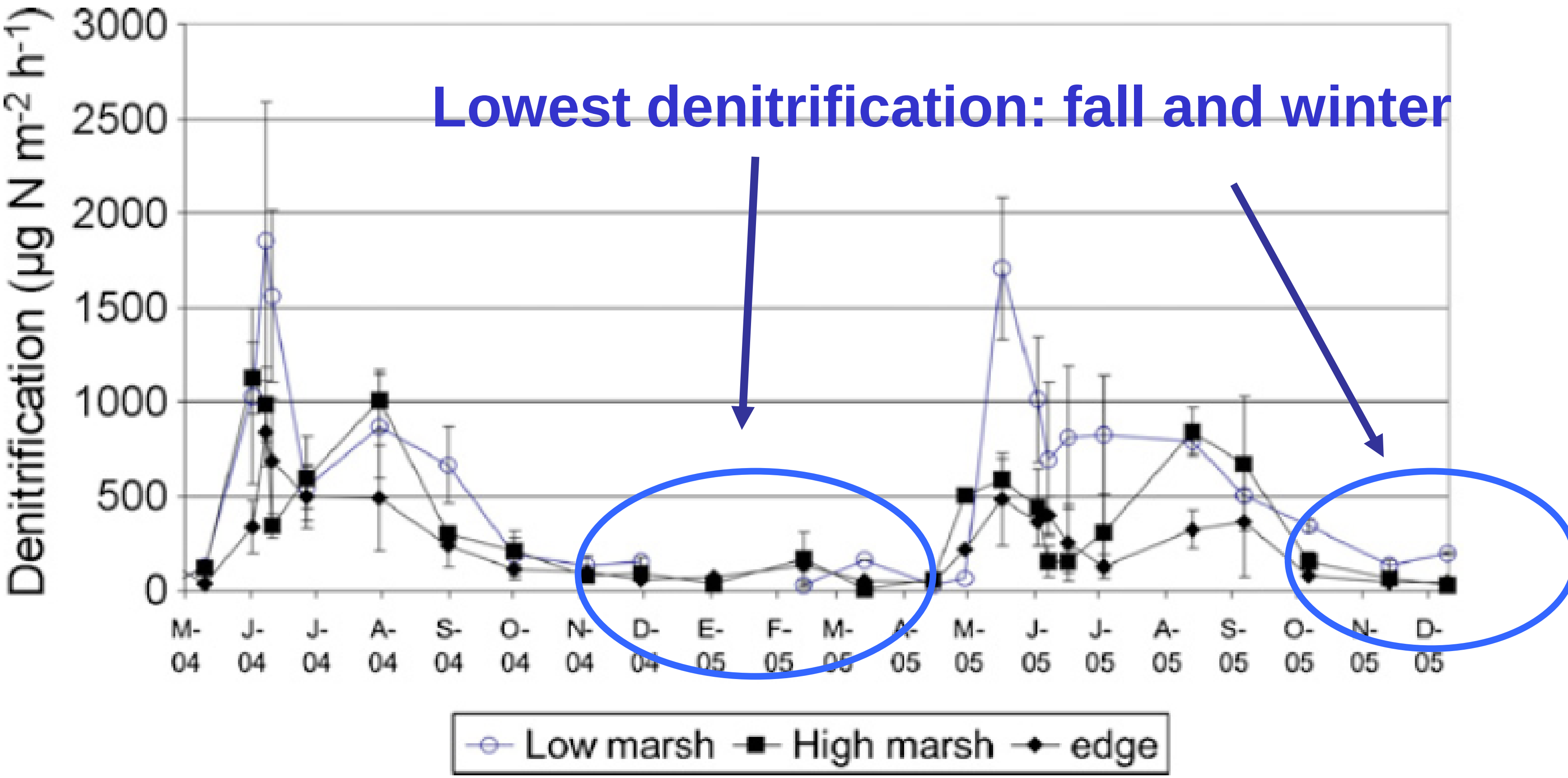


Results

Edge Zone



Results

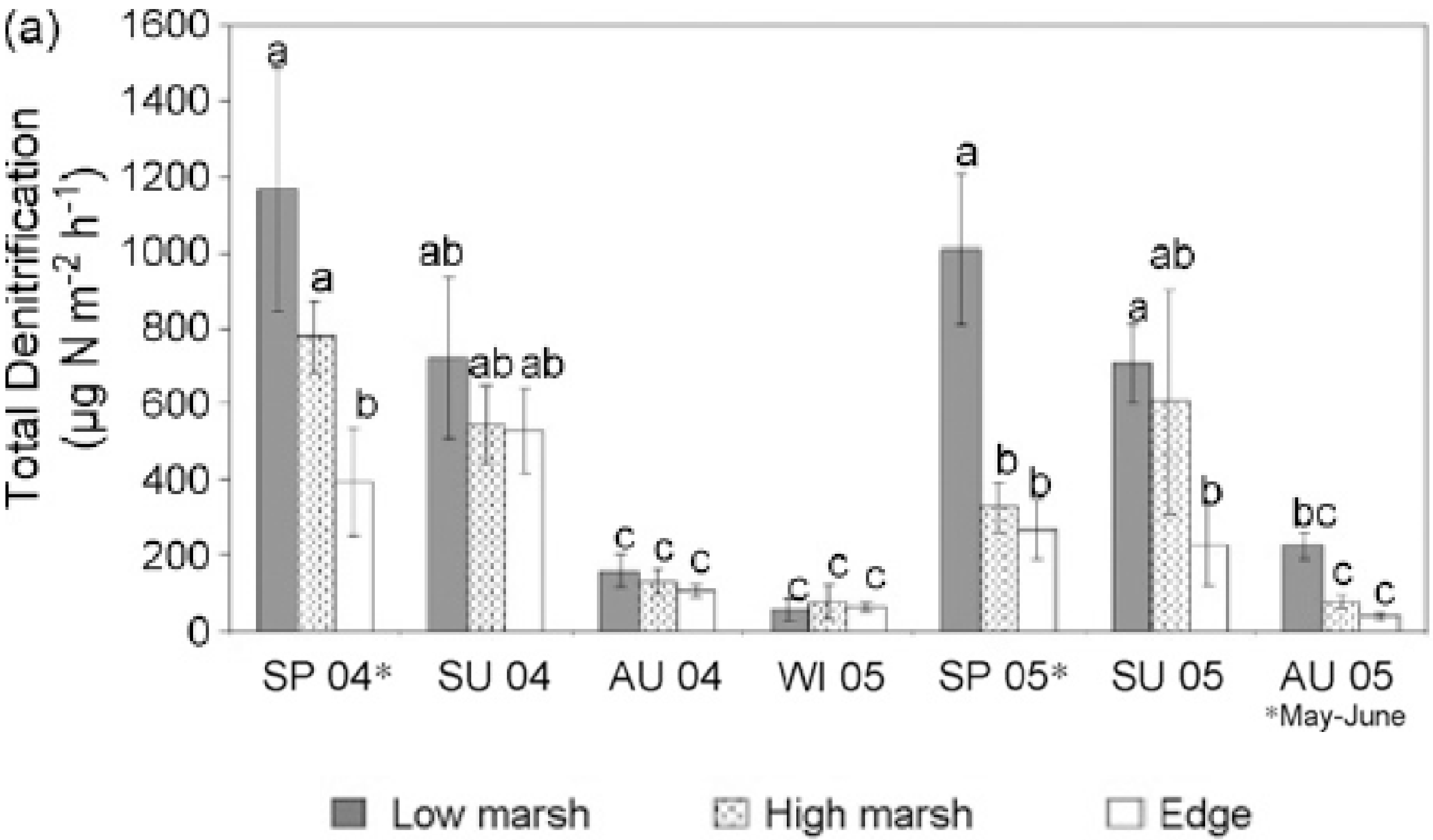

Lowest denitrification: fall and winter
Denitrification (µg N m-2 h-1)
3000
2500
2000
1500
1000
500
0
M-04
J-04
J-04
A-04
S-04
O-04
N-04
D-04
E-05
F-05
M-05
A-05
M-05
J-05
J-05
A-05
S-05
O-05
N-05
D-05
Low marsh
High marsh
edge

Results

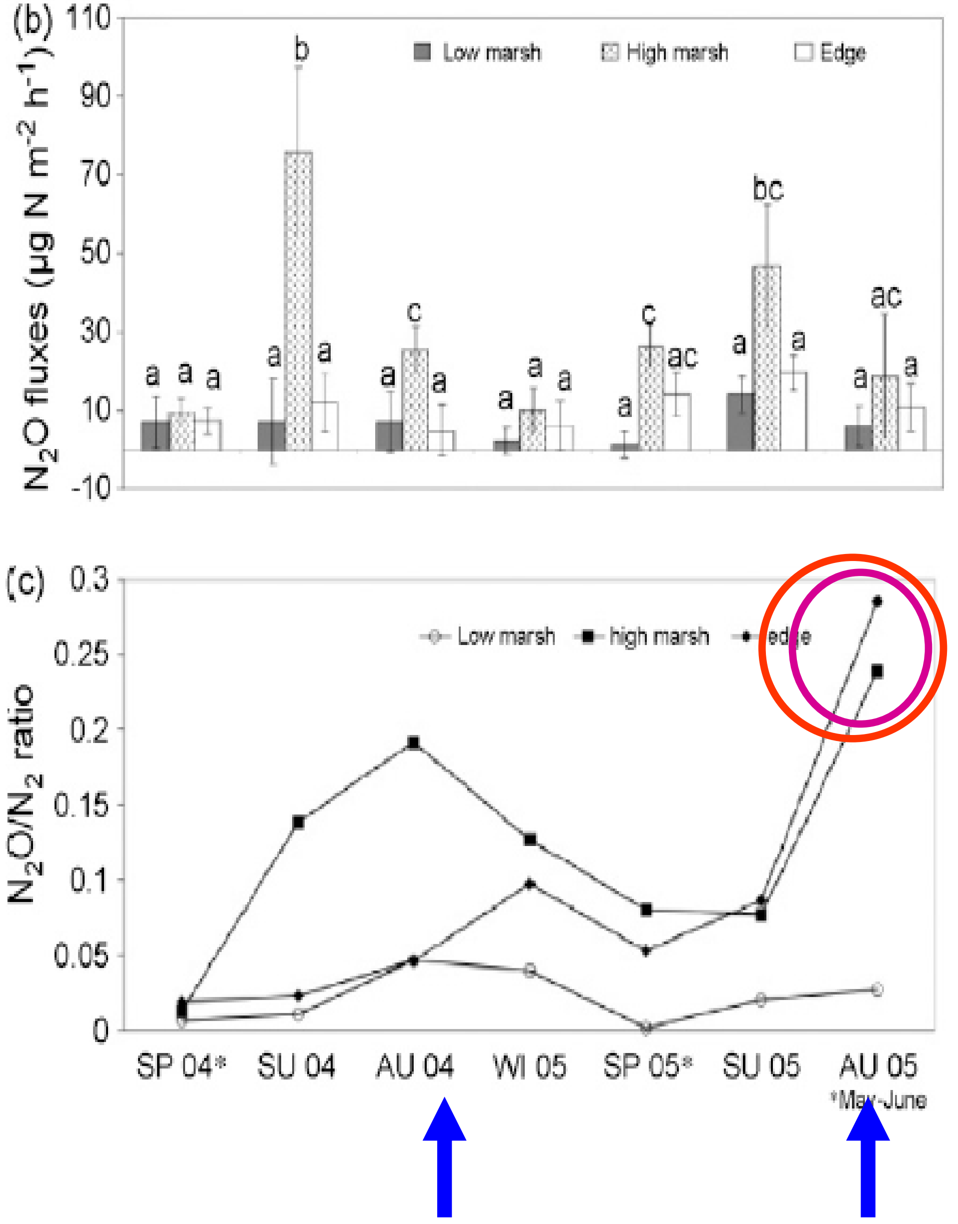
Low marches: similar rates in both conditions

High marches: higer rates under flood conditions in spring

Edge zones: not significant diffrences

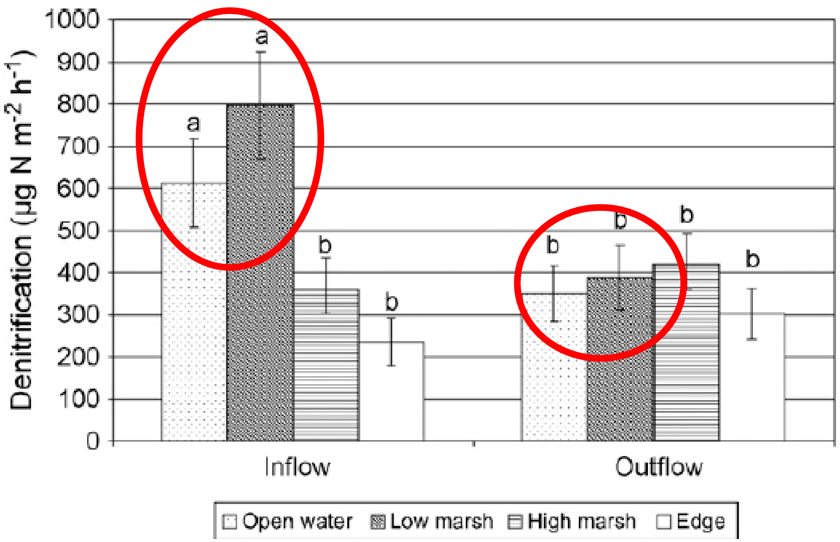


Results



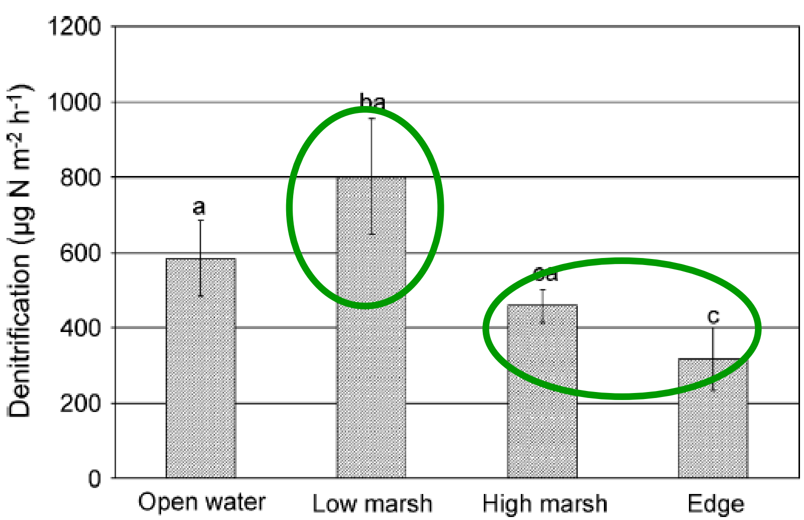
- ✓**Low N_20 emissions**
- ✓**Higher N2O/N2 ratios in high marshes an edge zones**
- ✓**N2O/N2 increased in cold seasons**

Results



Longitudinal gradient

✓Higher denitrification near the inflow (open waters and low marsh)

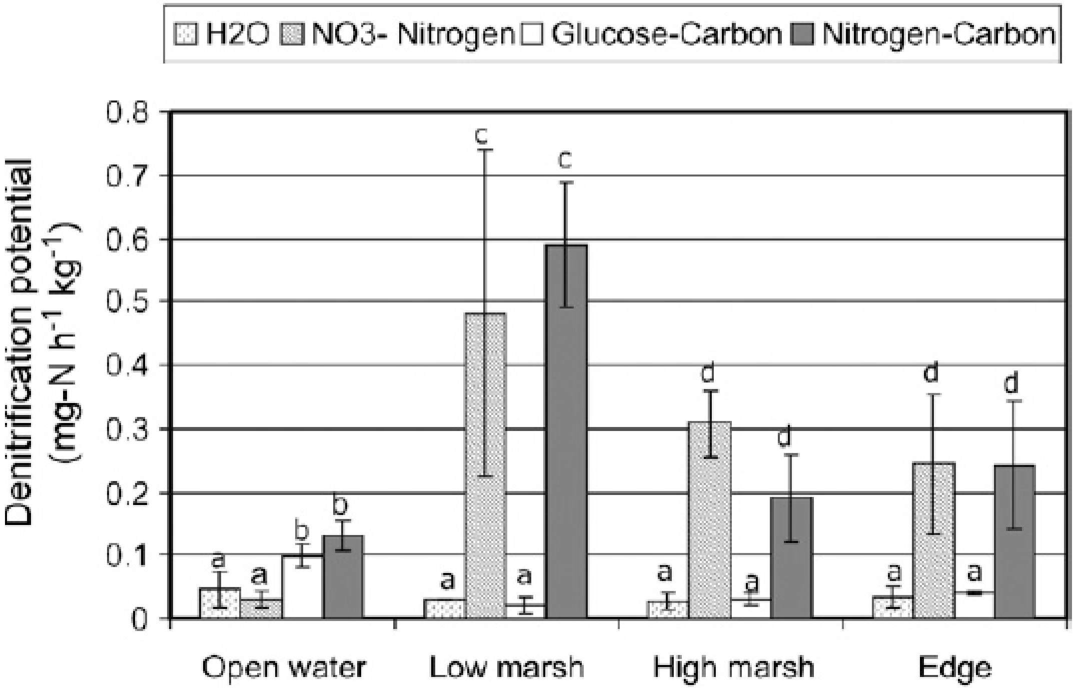


deep → shallow

Transverse gradient

✓Higher denitrification: low marsh zones, compared ti high marshes and edge zones

Results



Nitrate adition

Nitrate+Carbon

Conclusions

✓Denitrification rates in these created riverine marshes were strongly influenced by soil temperature and by hydrologic conditions in the transverse gradient of the wetlands.

✓Permanently flooded (open water and low marsh) zones showed higher denitrification rates than intermittent flooded zones (high marsh and edge).

✓Low marsh plots that were permanently flooded and vegetated with macrophytes showed the highest denitrification rates in the warmer season (spring and summer).

Conclusions

✓Flood pulses enhanced denitrification in high marsh and edge zones by creating alternate aerobic-anoxic conditions that favored both nitrification and denitrification.

✓Higher denitrification rates in the high marsh and edge zones during flood pulses led to higher mass of nitrogen lost by denitrification under pulsing conditions than under steady-flow conditions.

✓Denitrification in the low marsh, high marsh, and edge zones was nitrogen-limited, while denitrification in open water zones was both carbon- and nitrogen-limited.

Gracias!
Tak!
Dank!