Trace gas fluxes from The Tres Rios Wetlands Project in Phoenix, AZ

Jorge Ramos Jr.[1], Eric J. Chapman[1], Nicholas A. Weller[2], Dan L. Childers[2]
Wetland Ecosystem Ecology Laboratory
[1]School of Life Sciences, [2]School of Sustainability, Arizona State University, Tempe, AZ.

Introduction

- Wetlands provide valuable services, including the purification of water through denitrification, plant uptake, and soil retention.
- Wetlands are significant sources of trace gases, such as nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2).
- Constructed treatment wetland systems (CWS) in North America have been developed to remove nutrients from secondarily-treated water, but little is known about the contributions of CWS on trace gas emissions, especially in arid regions.

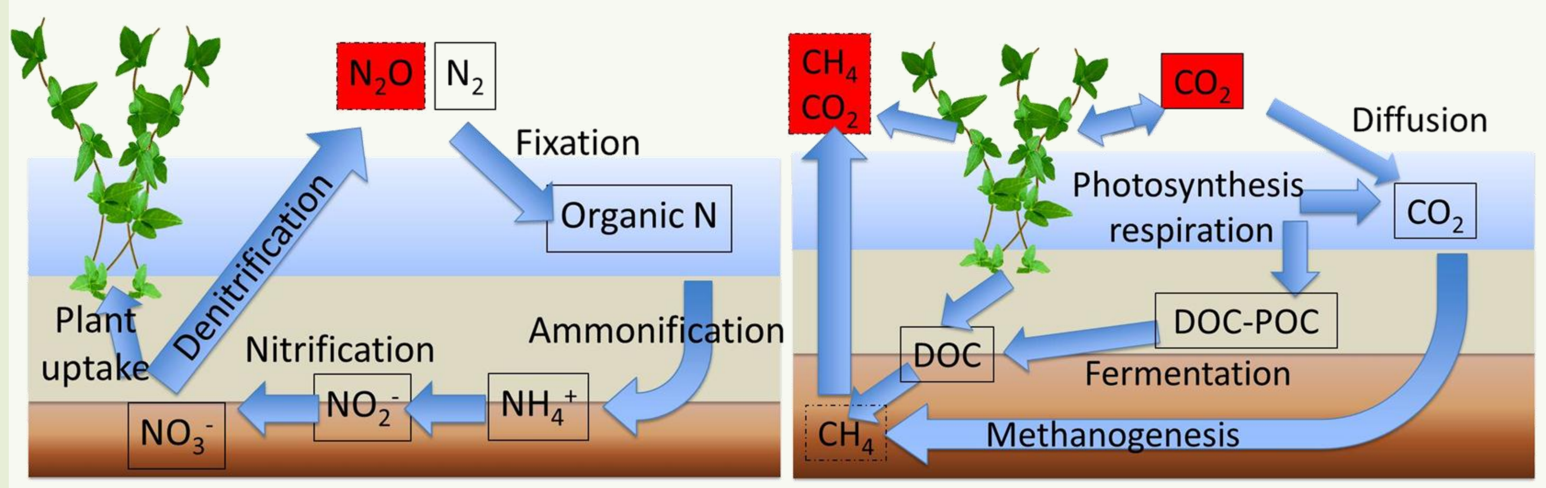

Fig. 1. Simplified conceptual model of the nitrogen (left) and carbon (right) cycle in wetland systems.

Site Description

- Free-water surface Tres Rios Constructed Wetland System
  - Located in the Phoenix metro area in central Arizona, USA.
  - Tres Rios CWS is approx. 200 ha. Study cell 1 is approx. 42 ha with 21 ha of wetland emergent vegetation (Fig 2).
  - Vegetation includes 7 emergent macrophyte species from the genera *Typha* and *Schoenoplectus.*
  - Area average high temperature ranges from 19 to 41°C and 200 mm of precipitation per year.
  - Average monthly evapotranspiration rates ranged from 0.79 cm/d in winter to 11.2 cm/d in summer.
  - System receives 114,000 m^3 of treated wastewater per day.
  - Approximate N loading rates: 650 kg N d^{-1} (1.55 g N m^{-2} d^{-1}).

Fig. 2. Aerial photo of the Tres Rios CWS.

Methods

- In cell 1 we assigned two study transects, one near the inflow of treated wastewater, and one closest to the outflow (Fig. 3).
- Each transect was divided into shoreline, vegetation, and open water subsites (Fig. 4).
- We applied the floating chamber technique in the transects of the Tres Rios CWS (Livingston and Hutchinson 1995).

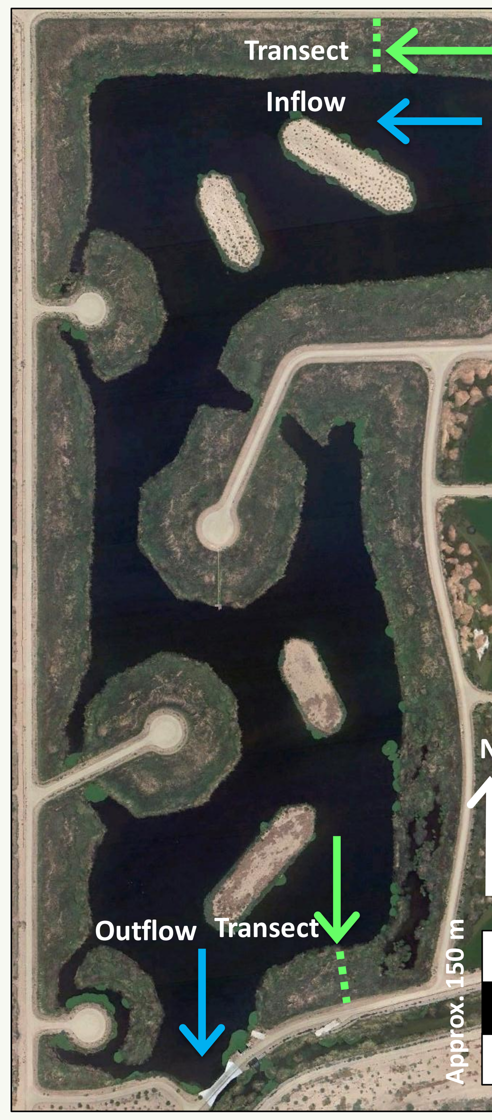

Fig. 3. Birds-eye view of cell 1 at Tres Rios CWS. Blue arrows depict inflow and outflow locations and green arrows show the location of the inflow and outflow transects.

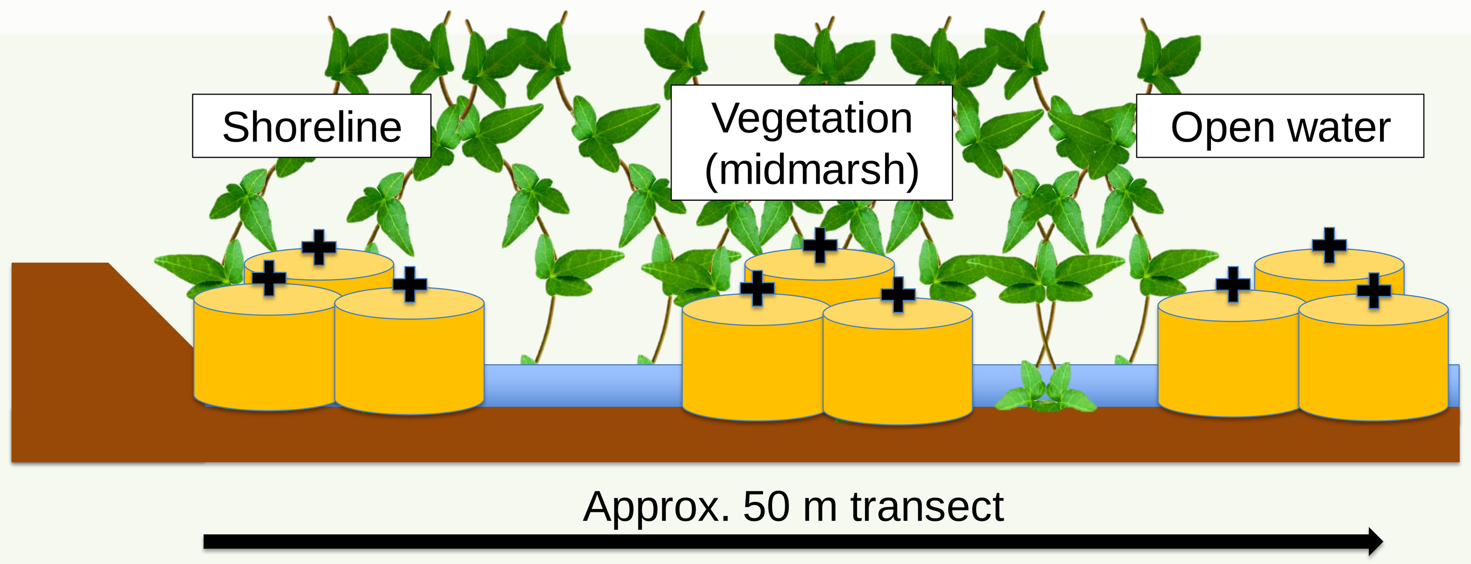

Fig. 4. Representation of chamber placement along a transect.

- We sampled three replicated chambers with floating collars simultaneously at 15-min intervals over a 45 min. period at 0800, 1000, and 1200.
- We analyzed samples using a Varian CP-3800 Gas Chromatograph.
- We calculated fluxes using the following equation:

$$Flux = V * C_{rate} / A$$

where V is the chamber volume, C_{rate} is the change in gas concentration, and A is the area enclosed by the chamber (Harrison and Matson 2003, Holland et al. 1999).

Fig. 5. Field placement of floating chambers on the shoreline (top), and gas sample collection (bottom).

Results

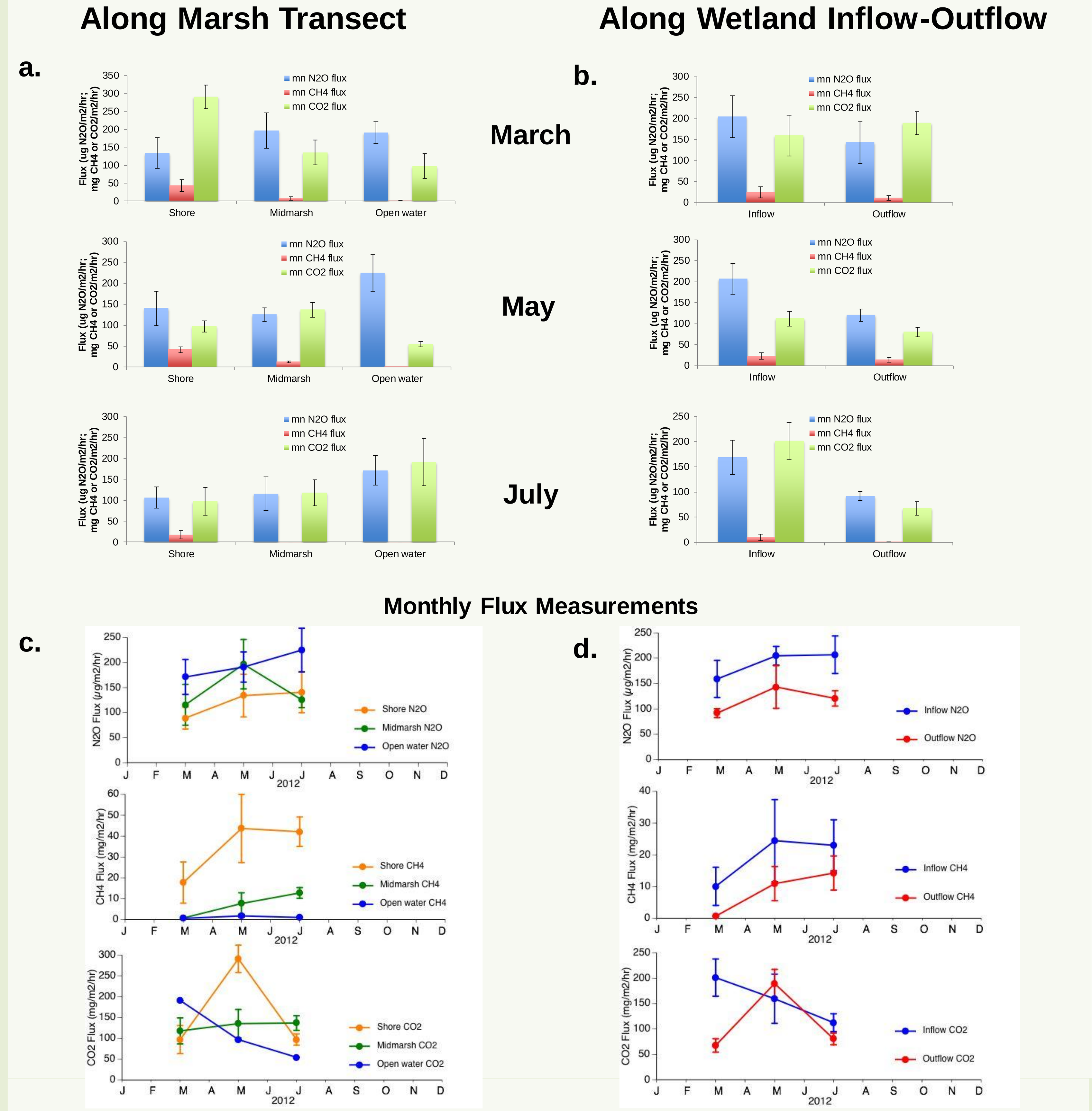

Fig. 6. Gas fluxes along the marsh transects (a), along an inflow-outflow whole-system (b), and a time series representation of the fluxes (c, d) from March to July of 2012.

Results

- We have observed an increase of N_2O and a decrease of CH_4 fluxes along the marsh transect. CO_2 fluxes have not been consistent through the sampled months (Fig. 6a).
- Lower N_2O and CH_4 fluxes have been regularly recorded at the outflow compared to the inflow (Fig. 6b). CO_2 fluxes have only followed this pattern in the months of May and July (Fig. 6b).
- An increase of all gas fluxes along the transect (with the exception of Open Water CO_2) have been observed from March to May. This pattern was not consistently continued throughout July (Fig. 6c).
- Overall greater fluxes have been recorded at the inflow compared to the outflow since March (Fig. 6d).
- Averaged CO_2 fluxes (135,494.1 µg CO_2-C m^{-2} hr^{-1}) were greater than averaged CH_4 (14,209.98 µg CH_4-C m^{-2} hr^{-1}) and averaged N_2O (156.23 µg N_2O-N m^{-2} hr^{-1}).

Acknowledgements: CAP-LTER Grad Grant and NSF for funding; Dr. Sharon Hall and Jenni Learned for GC support; WEEL members for their field and lab assistance; City of Phoenix Tres Rios Wetlands staff for their collaboration.

Literature cited: Harrison J. and P. Matson, *Global Biogeochem. Cycles* 17, 3 (2003); Holland et al., in Robertson, G.P., eds *Standard Soil Methods for Long-Term Ecological Research* (1999) Oxford University. New York, NY, USA; Livingston, G.P. and G.L. Hutchinson, in P.A. Matson and R.C. Harriss, eds, *Biogenic Trace Gases: Measuring Emissions from Soil and Water* (1995) Blackwell Science. Cambridge, MA, USA.