

Wetlands Solutions *for the Future*

Learning from ALFAwetlands and
REWET Projects

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Greenhouse gas emission reduction and biodiversity preservation through wetland restoration; A win-win scenario?

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Wetlands include a wide variety of ecosystems

- Main wetland types
 - Riparian wetlands in stream valleys and floodplains
 - Wet isolated low-lying areas in a terrestrial matrix
 - Coastal wetlands: salt marshes, mangroves



Peatlands, floodplain wetlands



Wetlands are declining rapidly, both in terms of spatial extent and environmental quality

- Degradation and destruction because of multiple pressures
 - **Hydrological stress:** water extraction, drainage
 - **Chemical stress:** Eutrophication and pollution with toxicants
 - **Physical habitat destruction:** peat extraction, conversion to agricultural grassland or commercial forest
 - **Exploitation of species:** fishing, hunting
 - **Invasion of non-indigenous species:** competition, predation, disease



Wetlands as biodiversity hotspots

- Wetland degradation is associated with **high biodiversity losses**
 - 40% of the worlds' known species are found in wetlands¹
- Habitat **heterogeneity** as key biodiversity driver
 - Gradients in environmental conditions from micro- to macroscale: wet-dry, nutrient poor-nutrient rich
 - Shifting mosaics due to spatiotemporal dynamics: flooding-drying cycles
- Rich in **wetland-adapted species**
 - habitat specialists



Landscape-scale heterogeneity



Meso



Micro

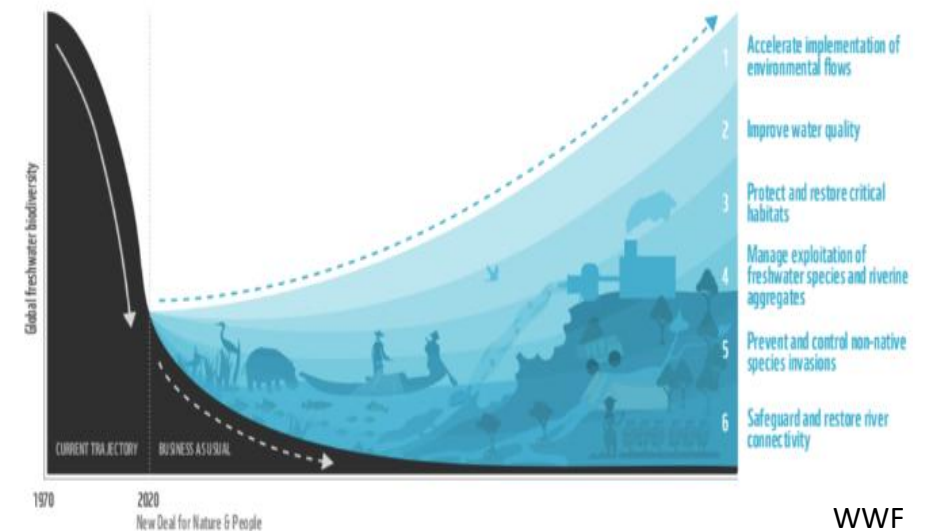
¹ Wetlands International

Wetland restoration: bending the curve of biodiversity loss¹

- Wetland restoration
 - Wetland **restoration initiatives are widespread and common** in Europe
 - Projects primarily and traditionally have **ecological goals**, driven by (inter)national nature and water legislation: N2000 Species and Habitats directive, Water Framework Directive
 - Recently additional goals are gaining importance: carbon sequestration, water retention - 'sponge landscapes'
 - **Rewetting is the key measure**, supplemented by measures targeting excess nutrients, vegetation management²



BENDING THE FRESHWATER BIODIVERSITY CURVE - AN EMERGENCY RECOVERY PLAN

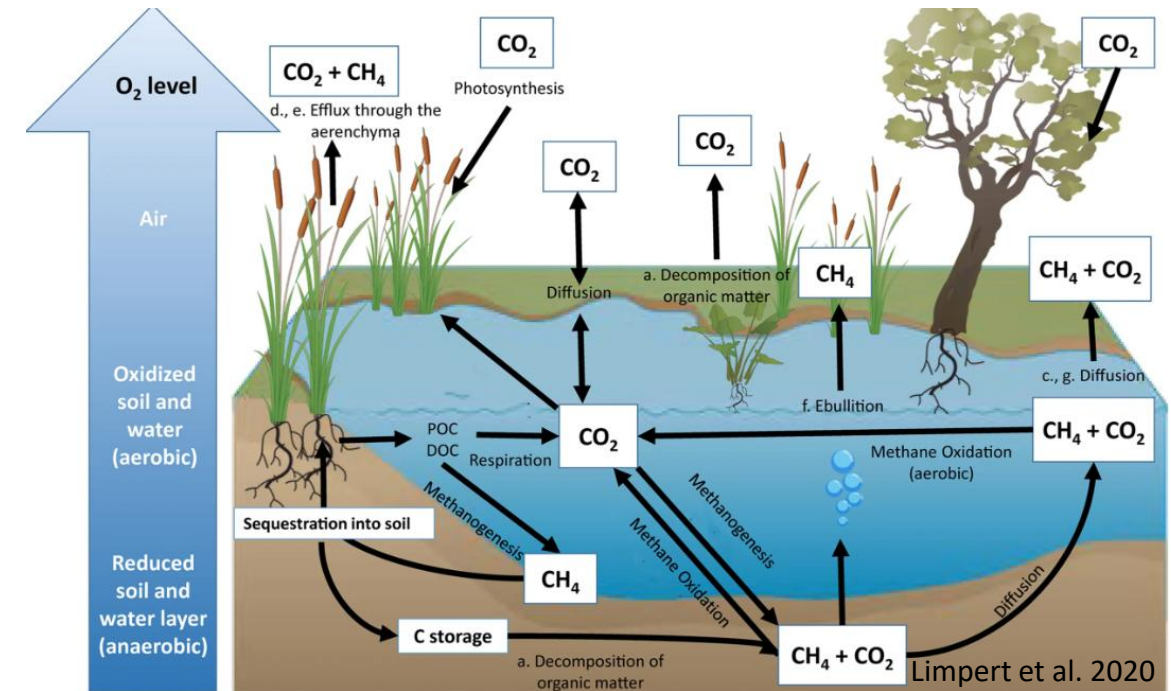


WWF

¹ Tickner et al. 2020, 10.1093/biosci/biaa002; ² Pfadenhauer & Grootjans 1999, 10.2307/1478886

Multiple ecosystem service gains from ecological wetland restoration; wetlands as carbon sinks

- Rewetting could improve the wetland carbon sink strength^{1,2,3}
 - **Reduction of emissions** because of lower decomposition rates and higher uptake by plants, CH₄ emissions might show a marked (temporal) post-restoration increase.
 - **Increased storage of C** in accumulated not decomposed organic matter



- Applying wetland restoration measures which improve both biodiversity and simultaneously reduce emissions comprises an ecosystem services win-win scenario⁴

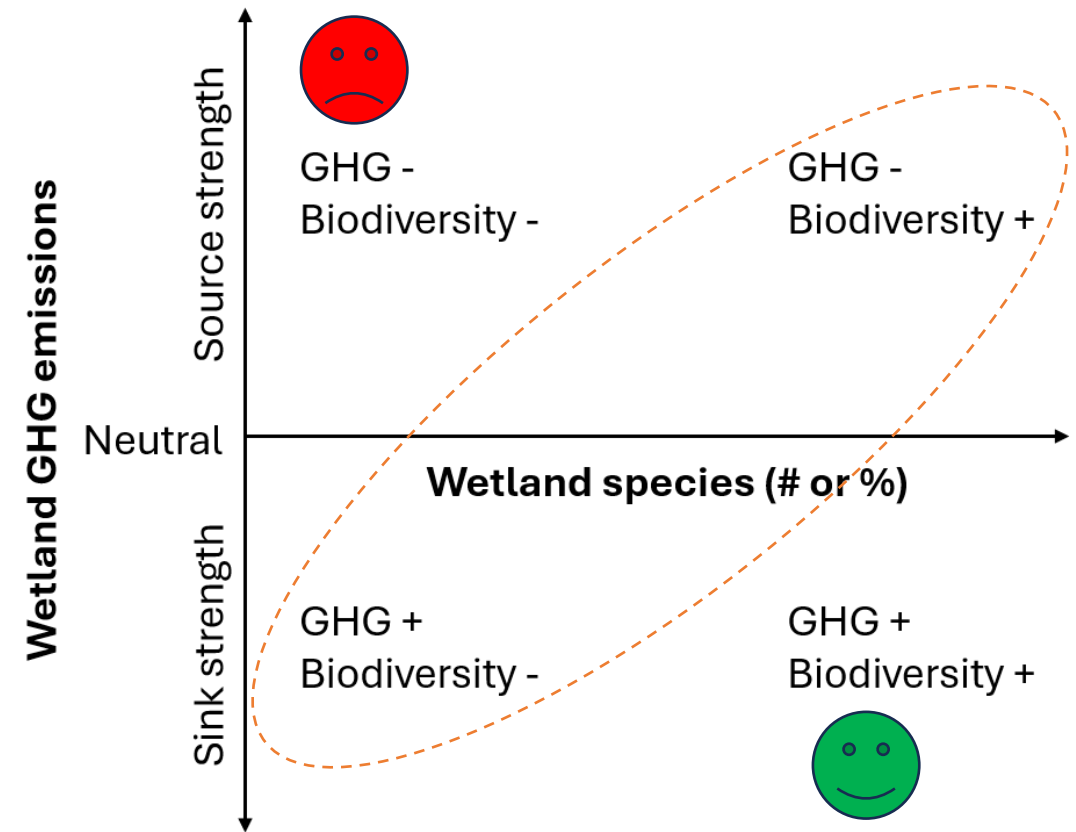
¹He et al. 2024, 10.1038/s41467-024-46991-5; ²Zhang et al. 2026, 10.1016/j.eiar.2026.108441; ³Limpert et al. 2020 10.3389/fenvs.2020.00008; ⁴Convention on Wetlands 2025, 10.69556/GWO-2025-eng.

Risk of potential trade-offs between ecosystem services in wetland restoration

- Contrasting responses to restoration between sites in terms of GHG emissions and biodiversity are observed¹
 - Trade-offs or antagonistic relationships



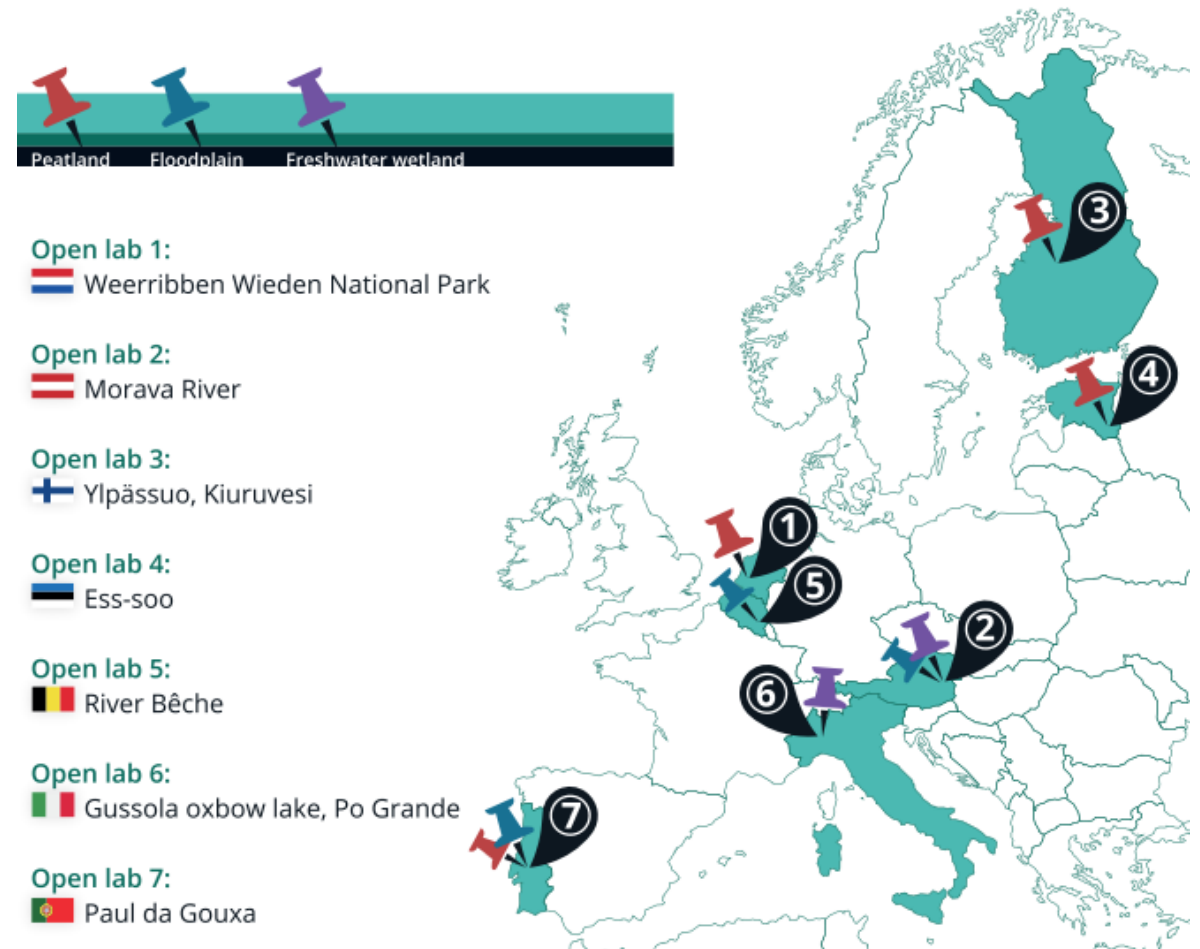
Trade-offs -> wetland management decisions



¹ Ascenzi et al. 2026. 10.1111/geb.70199

Insights from the REWET project: which responses are observed when biodiversity and GHG emission outcomes are compared?

- Wetland annual **greenhouse gas budgets** and **biodiversity indicators** were studied between 2023-2026
- Rewetted sites along a cross-European habitat and climate gradient: 7 'Open labs'



Open lab field measurements: greenhouse gas emissions

- Sites with semi-continuous measurements of CO₂ and CH₄ fluxes using **Eddy covariance**
- Cumulative sum of **net ecosystem CO₂ and CH₄ fluxes** over one year for the wetland restoration sites: carbon source – sink estimation

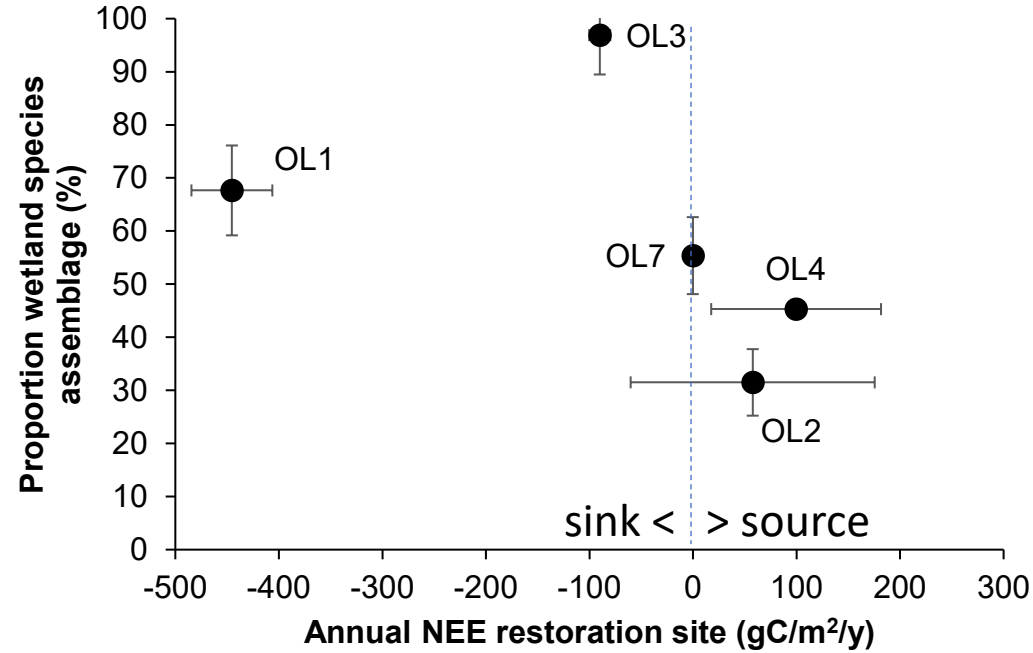
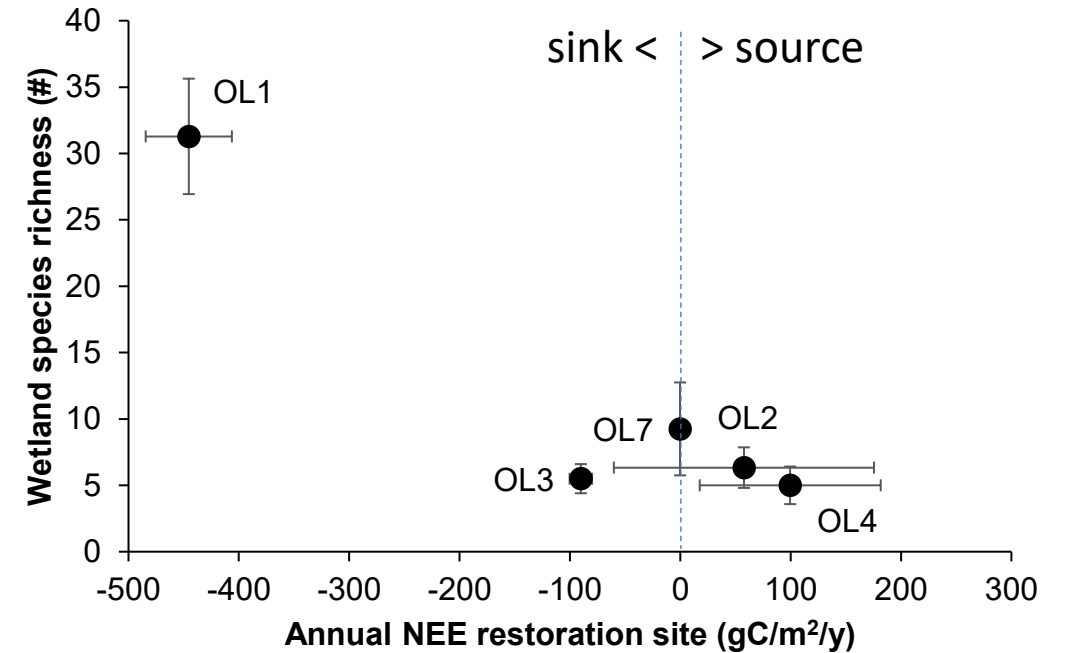


Open lab field measurements: biodiversity

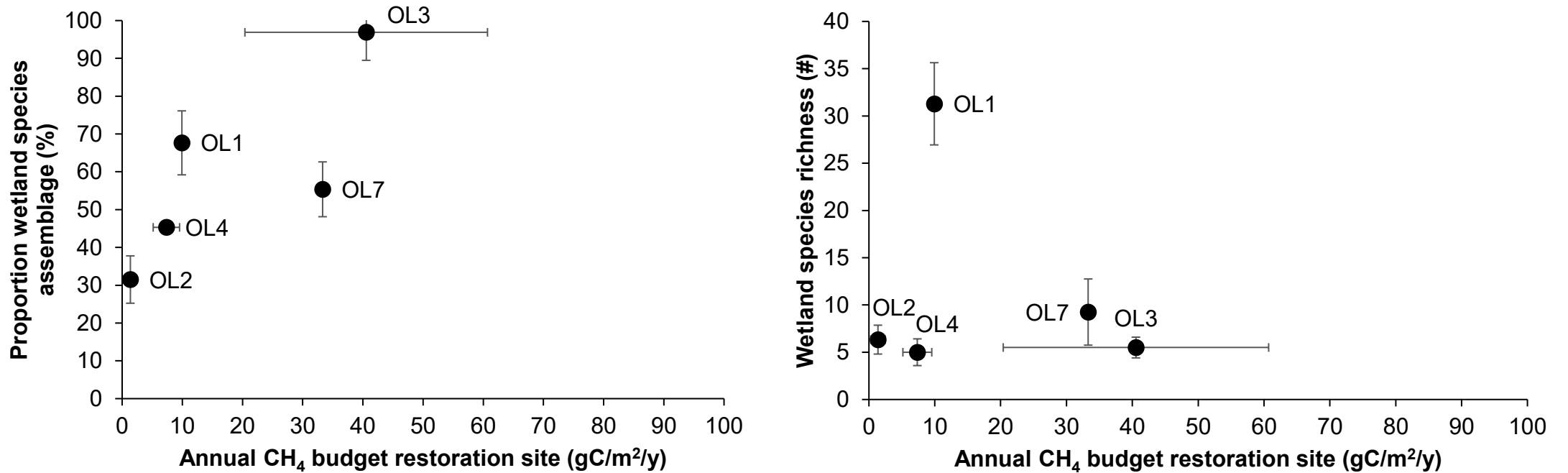
- Pitfall trapping of **ground beetles** (Coleoptera: Carabidae)
- **Vegetation** relevés to determine plant species composition and proportional cover
- Specific focus on **wetland species**, not total number
- Selection based on European trait database information



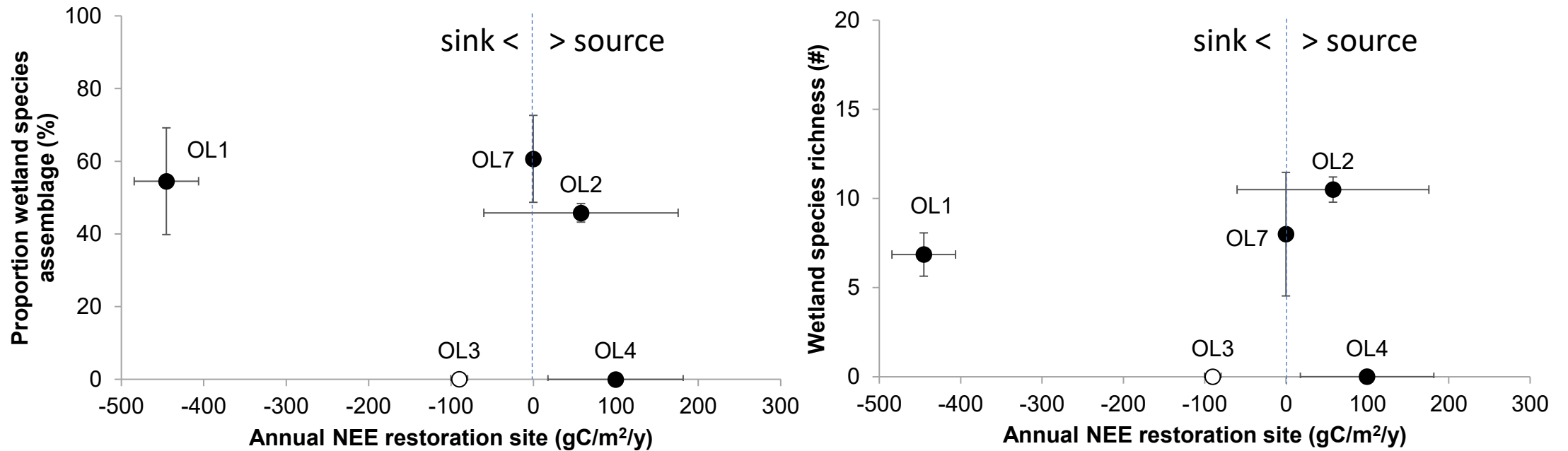
Results wetland plants – CO₂ fluxes



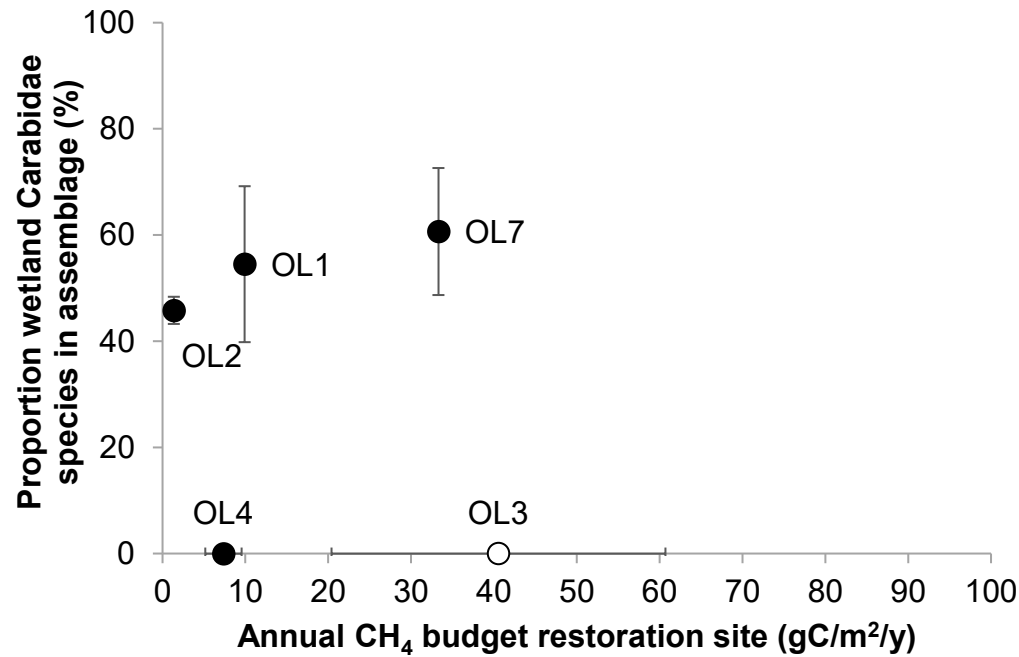
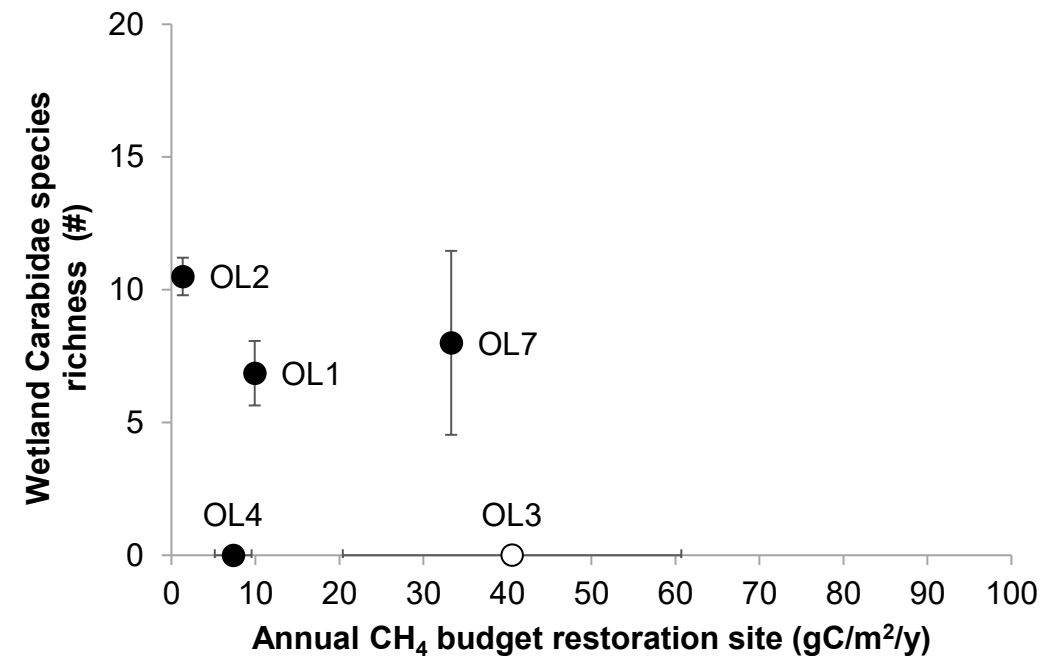
Results wetland plants – CH₄ emissions



Results wetland ground beetles – CO₂ fluxes



Results wetland ground beetles – CH₄ emissions



Conclusions and recommendations

1. Although rewetting could lead to beneficial effects on both wetland biodiversity and GHG emissions, the REWET open lab case studies show that **the outcomes are highly context dependent**.
2. Investing in **monitoring** is key in determining restoration outcomes for different ecosystem services and to gain a better understanding of the underlying mechanisms
 - A win-win outcome in terms of both GHG could not be claimed without proper monitoring.
 - Strong need for restoration monitoring time series, including both biodiversity indicators and GHG flux measurements: before-after control impact (BACI) monitoring design to determine location specific changes over time controlled for external factors.
 - This monitoring setup could also be used for adaptive management of the restoration site.

THANK YOU

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Concluding Remarks

