Bicarbonate Utilization Potential: pH Drift Studies

Dr. Robert Doyle and Ms. Sarah Hester

HCP Science Committee Meeting

February 5, 2014

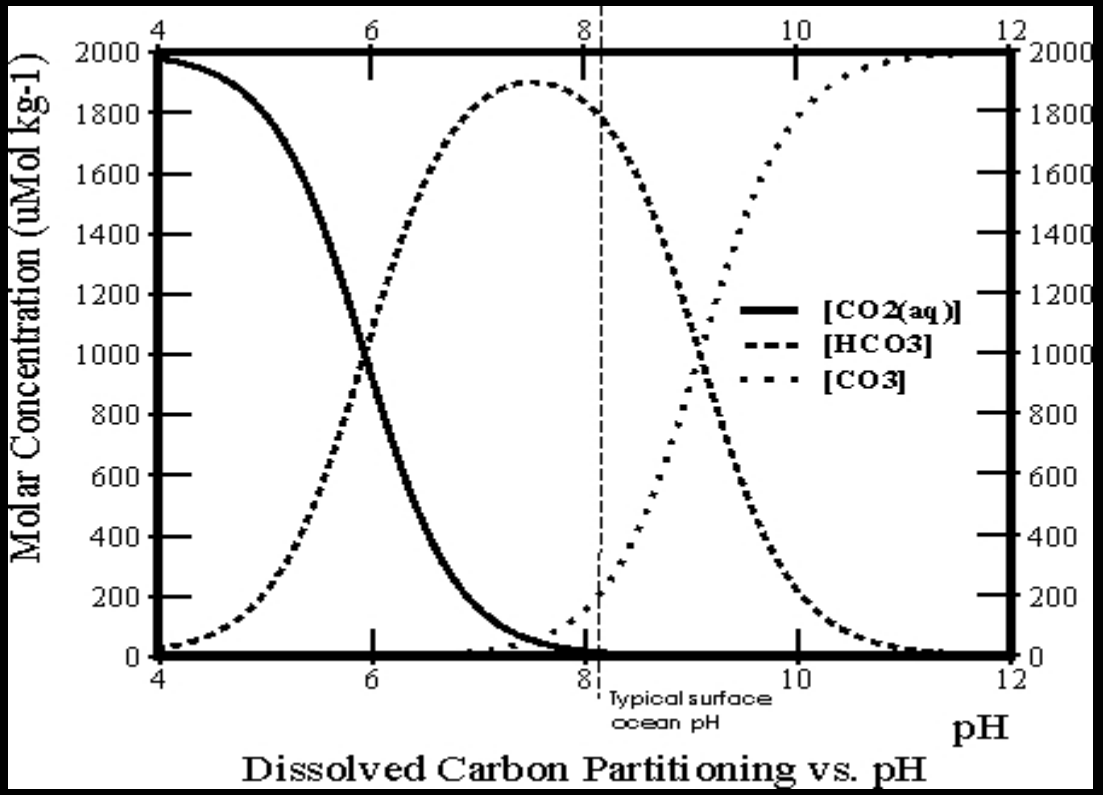
BAYLOR UNIVERSITY
Center for Reservoir and
Aquatic Systems Research

BIO-WEST

Applied Research: pH Drift Studies

- **Objective:** Determine which aquatic plant species are capable of HCO_3 utilization
- **Rationale:** Under low-flow conditions pH likely increases making CO_2 less available
- **Approach:** Assay plants under closed-system conditions and see how far they can "push" pH.
  - CO_2 obligates: Ps stops when CO_2 depleted
  - HCO_3 users: Ps continues to higher pH

Experimental Approach

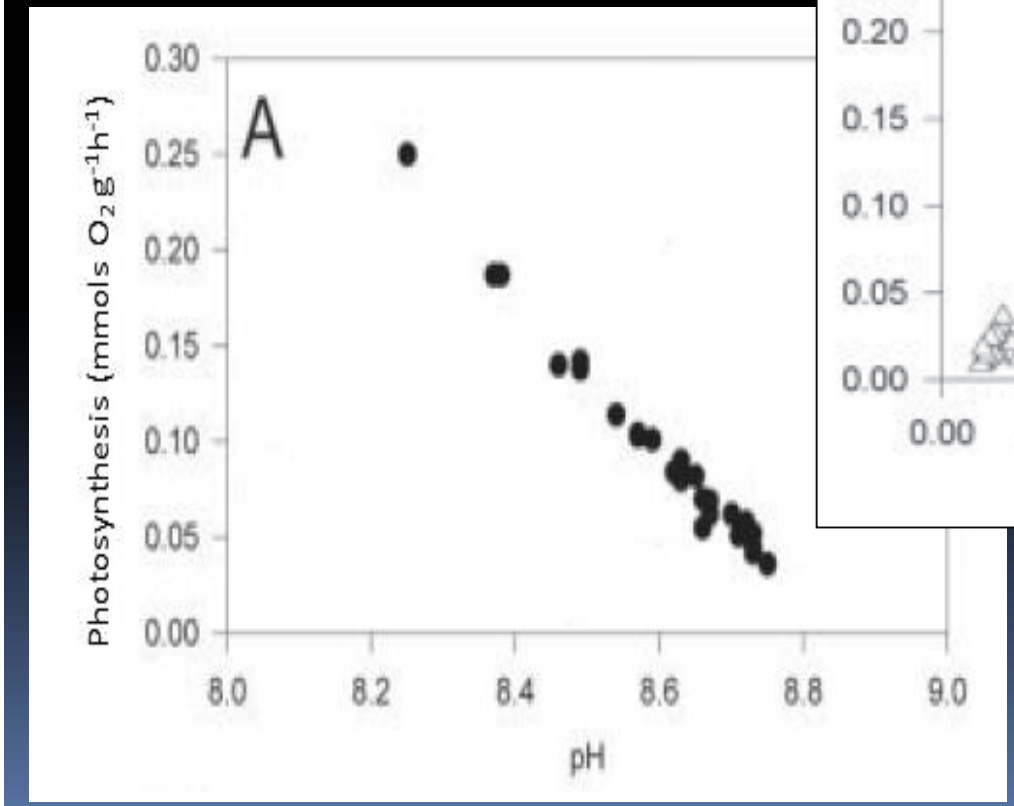


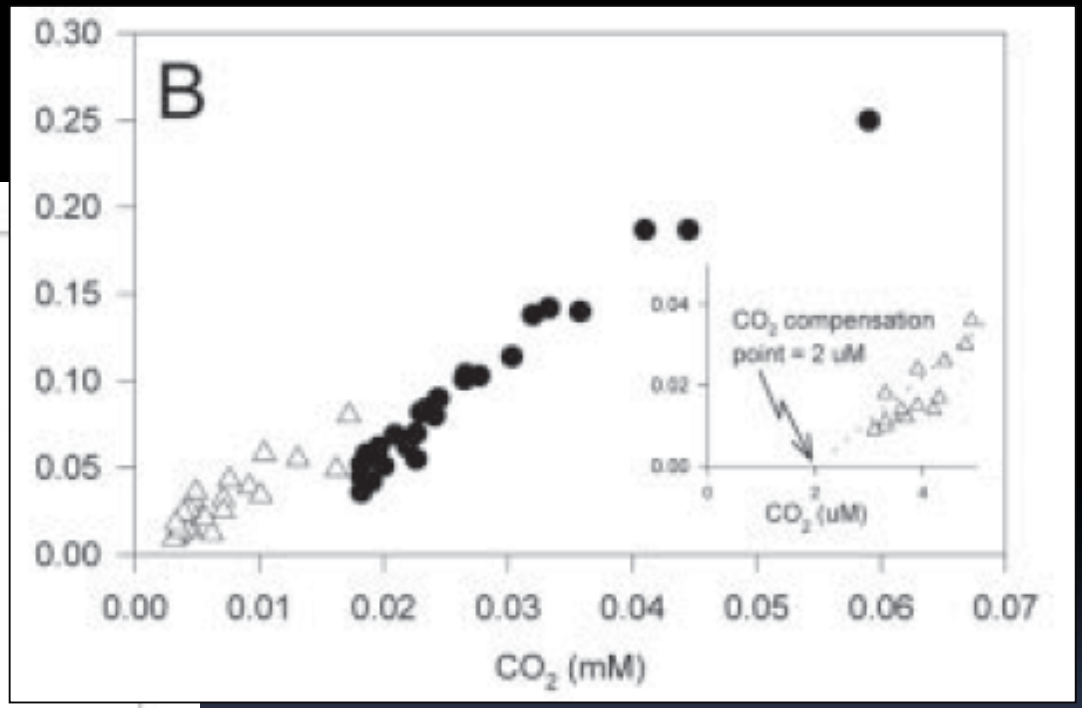
Recall speciation of Dissolved Inorganic Carbon is pH-dependent

As Ps takes place, DIC (=carbonic acid) utilized and pH rises

Methods

Ps vs. pH or CO_2 for TX wildrice
(from Power & Doyle 2004)





Methods

- Use synthetic Ps solution (known alkalinity and carbon composition). Initial pH about 8.3 (not much CO_2 present).
- CO_2 depletion lowers total inorganic carbon (C_T) only modestly. HCO_3 use lowers C_T more strongly.
- Loss of CO_2 and HCO_3 does not change alkalinity as (OH^-) replaces alkalinity lost.
- C_T:Alk ratio becomes sensitive measure of bicarbonate utilization potential.

Methods

- Plants collected from Comal analyzed under three culture conditions
  - **Freshly collected plants** (are plants utilizing bicarbonate under current *in situ* conditions>
  - **Lab cultures amended with CO_2** (in culture- but plenty of CO_2 available)
  - **Lab cultures without CO_2** (growth in CO_2 – stressed conditions- can species be induced to utilize bicarbonate?
- In addition, plants from temperature threshold study (28 & 34 C cultures under low CO_2 conditions)

Methods

Analyses

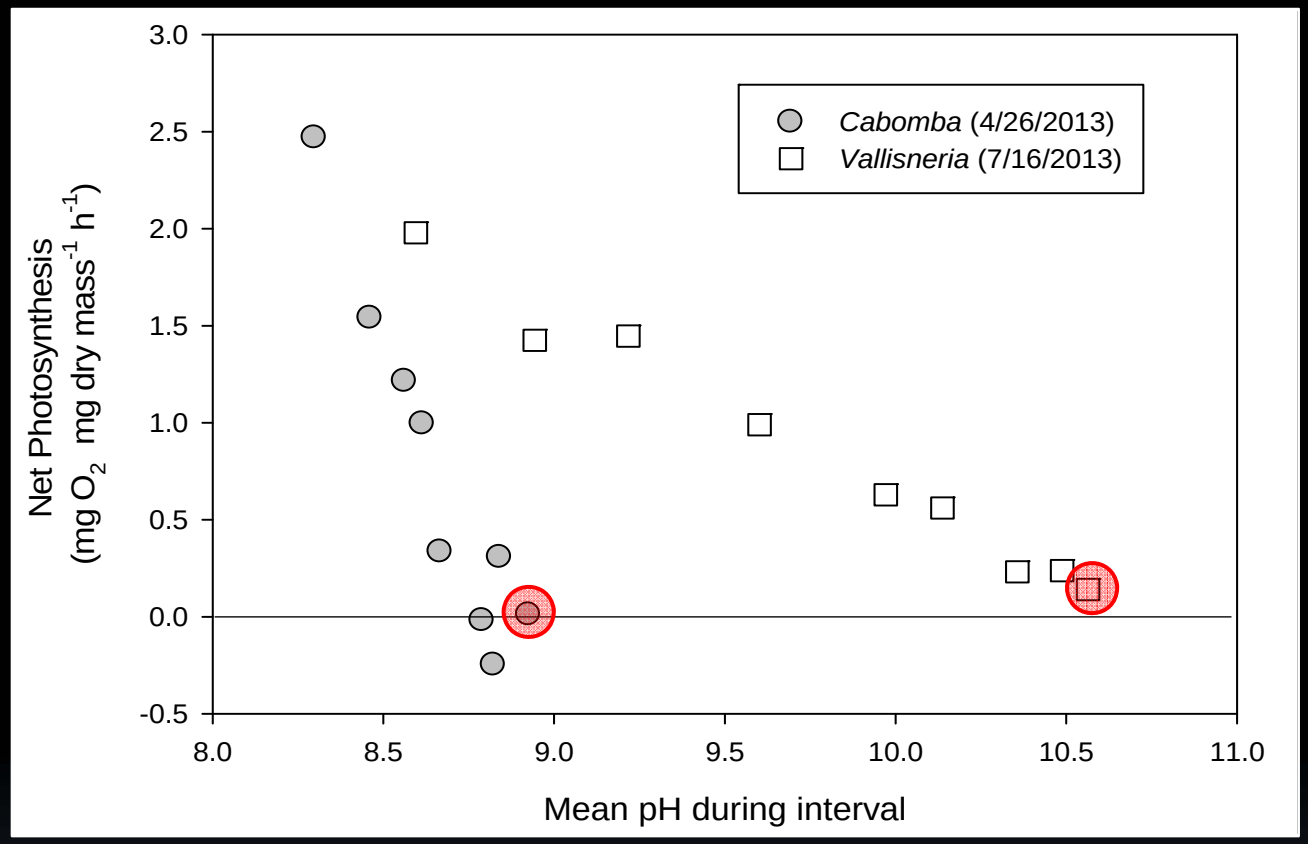
Focus on major Comal species: *Hygrophila, Ludwigia, Cabomba, Vallisneria, Sagittaria &* bryophyte

Key response focus = final pH & C_T:Alk ratio

The "better" a species can use HCO_3, the <u>higher</u> they can push (drift) pH and the <u>lower</u> the C_T:Alk ratio

One-way ANOVA will allow comparison among species & culture conditions.

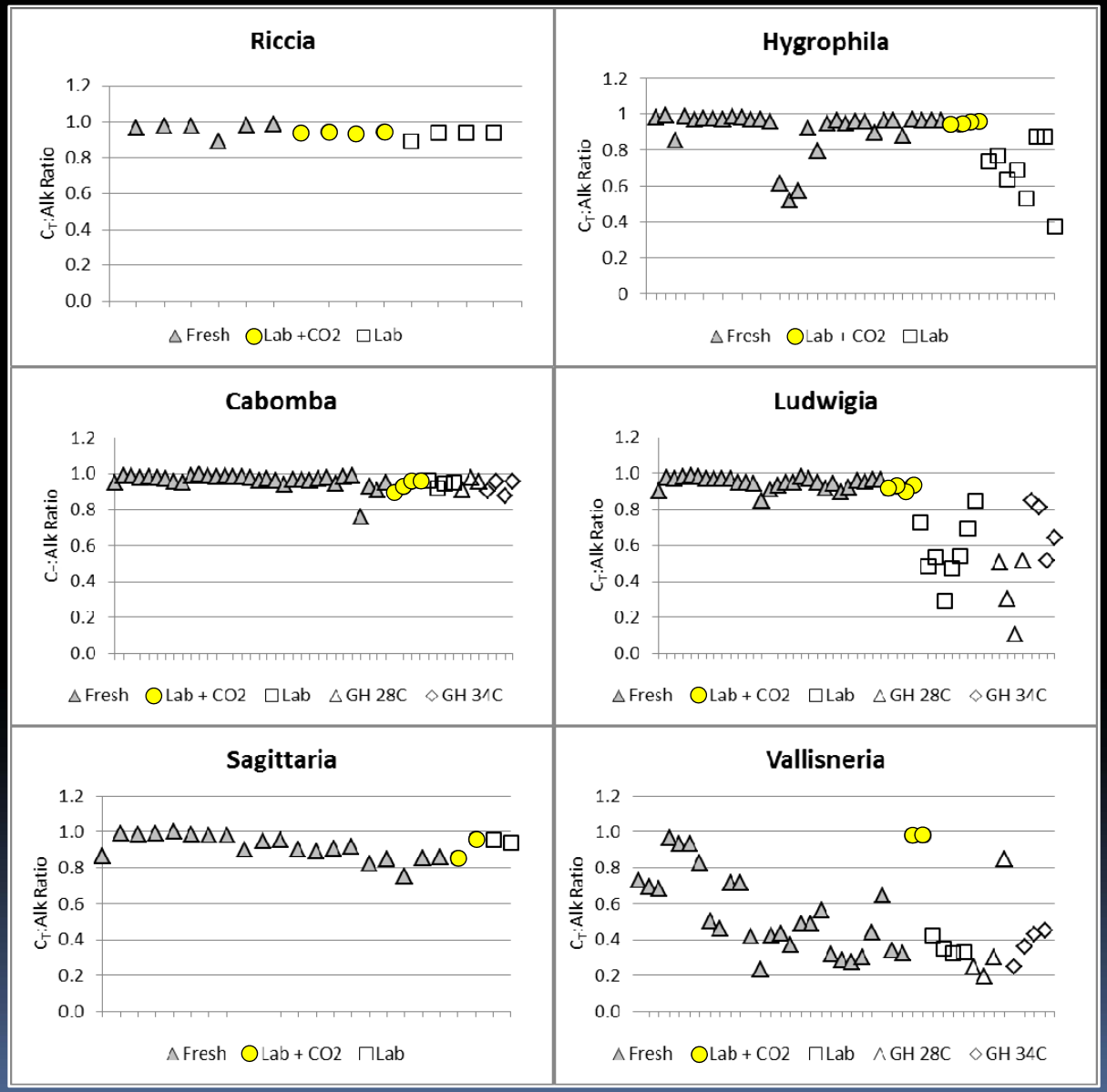
Results



Example results for bicarbonate user (*Vallisneria*) and non-bicarbonate user (*Cabomba*).

Calculate CT:ALK ratio for highest pH (or pH where PS drops to zero)

Results



A) Riccia, Cabomba & Sagittaria

No evidence of bicarbonate utilization potential

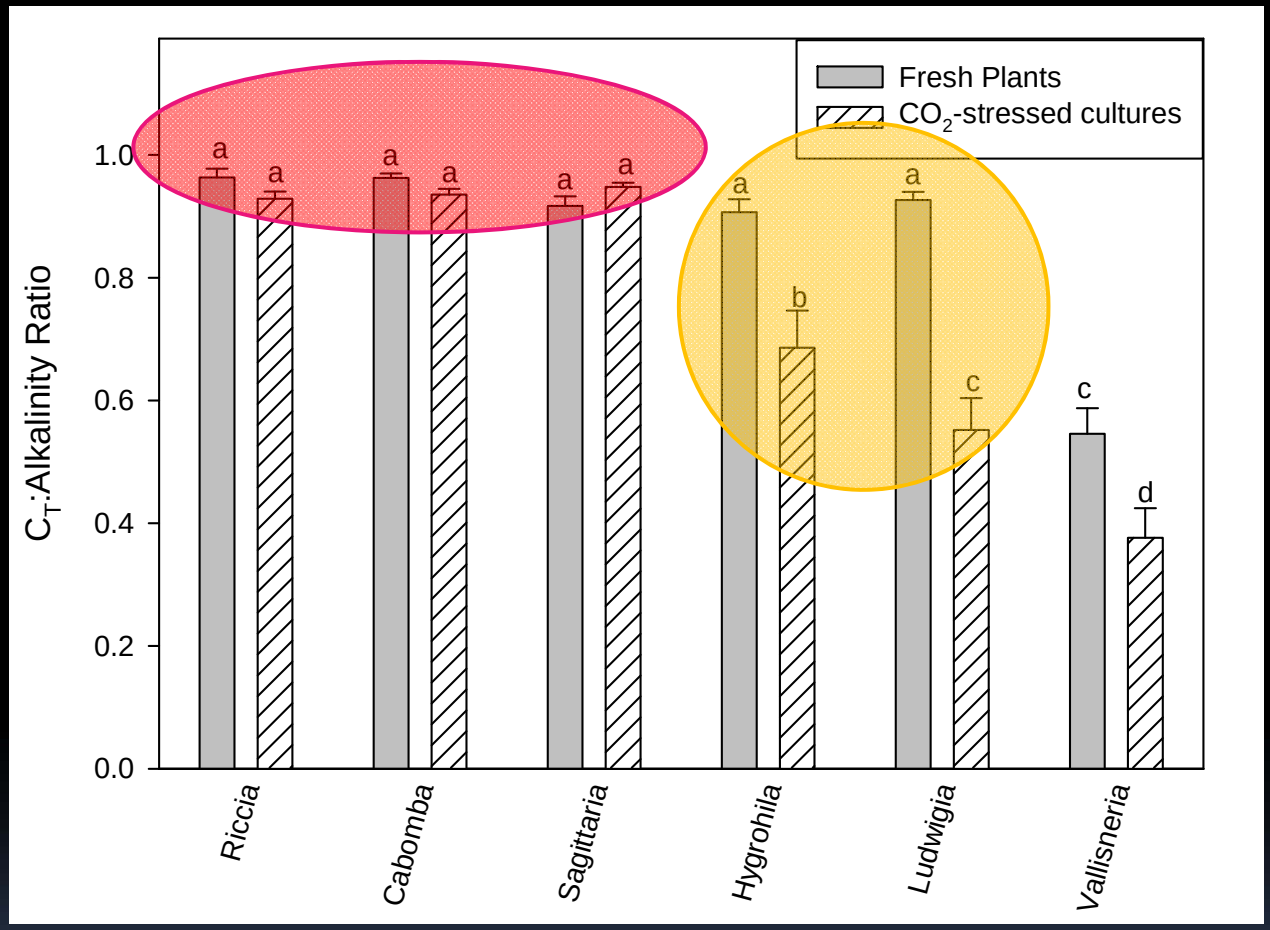
B) Hygrophila & Ludwigia

Not (usually?) using bicarbonate now- but clear evidence of induced utilization

C) Vallisneria

Strong bicarbonate user

Results (one-way ANOVA)



A) Riccia, Cabomba & Sagittaria (not bicarbonate users)

B) Hygrophila & Ludwigia (utilization induced by CO_2 stress)

C) Vallisneria (strong bicarbonate user & get stronger under stress)

Summary

Study determined bicarbonate utilization potential for six key species within the Comal/SM system

3 species (*Riccia, Cabomba & Sagittaria*) are not using bicarbonate now and show no evidence that utilization can be induced.

2 species (*Hygrophila & Ludwigia*) not (?) using now- but clear evidence that utilization can be induced by CO_2 stress

1 species (*Vallisneria*) is a strong bicarbonate user and gets even stronger under CO_2 stress