The role of salt marsh as a net sink or source of carbon dioxide in Southwestern Gulf of Mexico

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Salt marsh ?

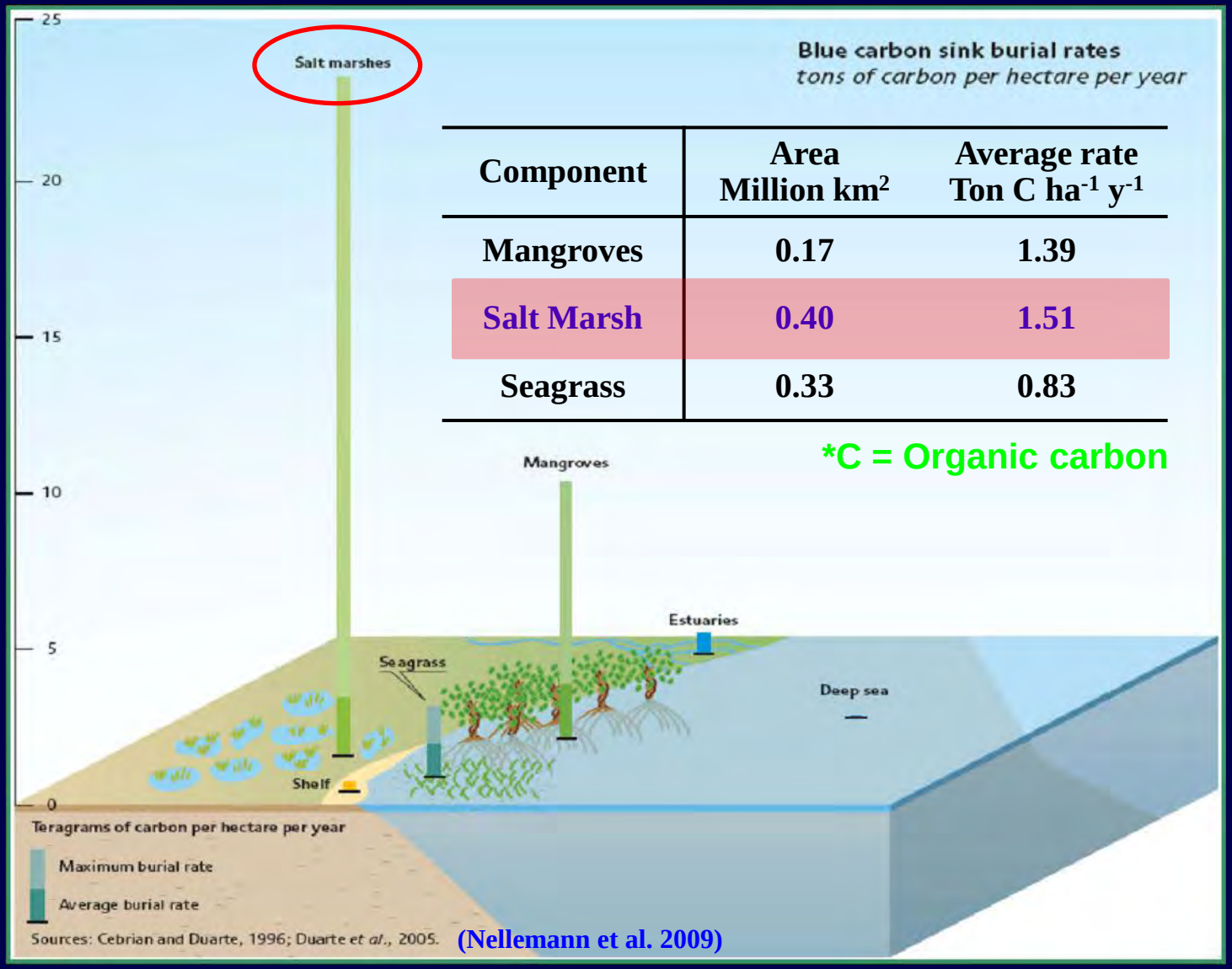
- Transition zones between the ocean and the land

Functions and values

- High primary productivity
- Variable habitat ⇒ high biodiversity
- Nutrients recycling and filtration
- Wave and current energy damping

Thus, one of the most valuable ecosystems (Costanza et al. 1997)

Carbon sequestration in Salt marsh



Component	Area Million km^2	Average rate Ton C ha^{-1} y^{-1}
Mangroves	0.17	1.39
Salt Marsh	0.40	1.51
Seagrass	0.33	0.83

*C = Organic carbon

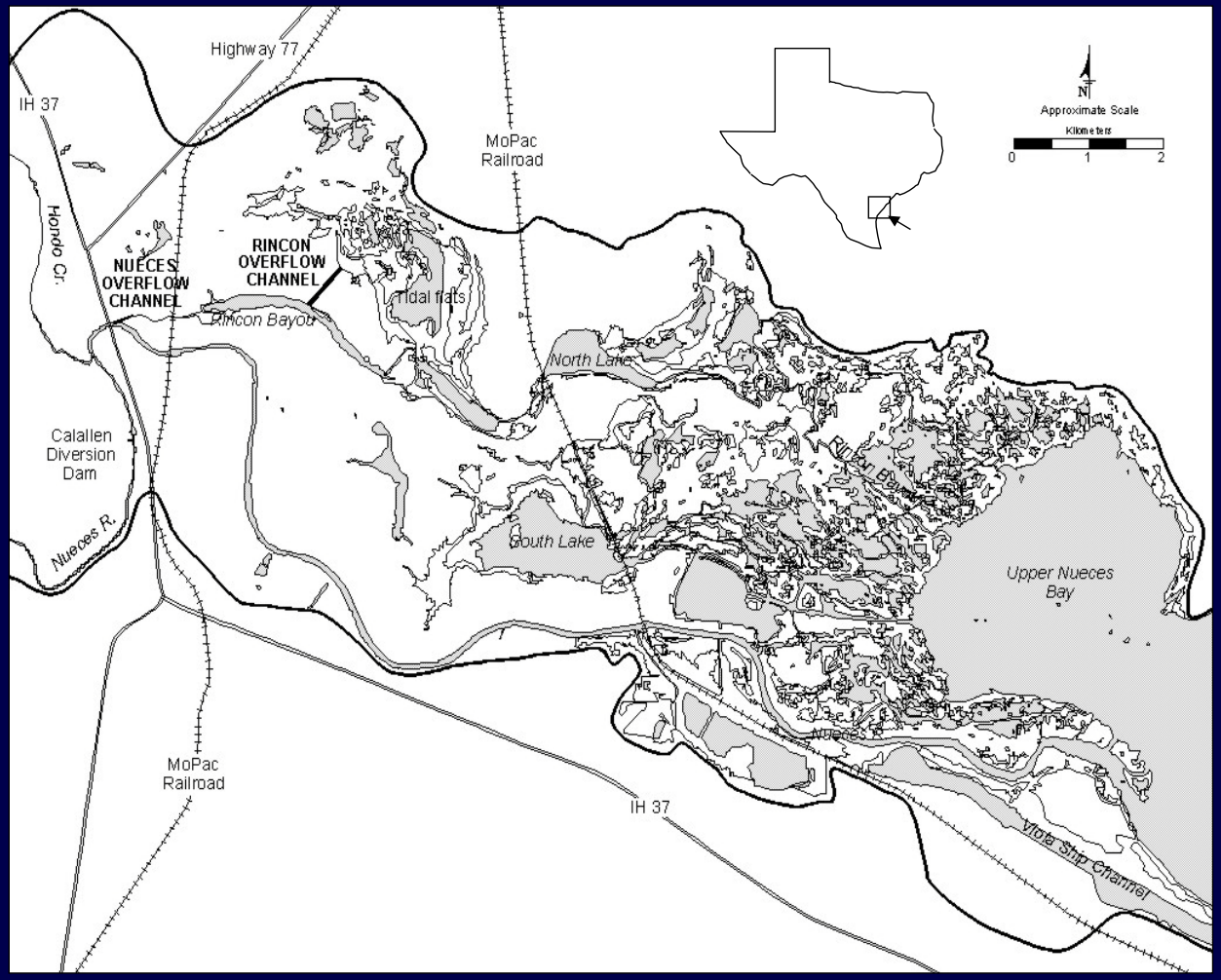
(Nellemann et al. 2009)

Salt marshes decline

- Disappeared about 50% of marsh systems in U.S.
  (Kennish 2001)

Nueces River Delta

- A part of the Nueces estuary system in Southwestern Gulf of Mexico (5700 ha)



Nueces River Delta

- *Borrichia frutescens* (Bf), *Batis maritima* (Bm), and *Salicornia virginica* (Sv)

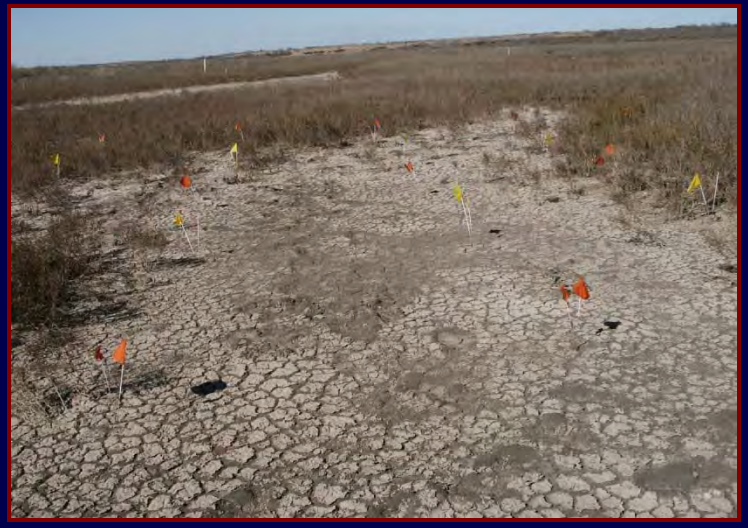
- 50% of vegetation cover

- Since 1940, reduced freshwater input (over 99%)

- Hypersalinity and water stress

- Since 1940s, decline of 30-40% of net aerial primary production (Ward 1987, Solis 1994)

- But, little photosynthetic research



Objectives

Quantify the seasonal photosynthetic characteristics of marsh plants

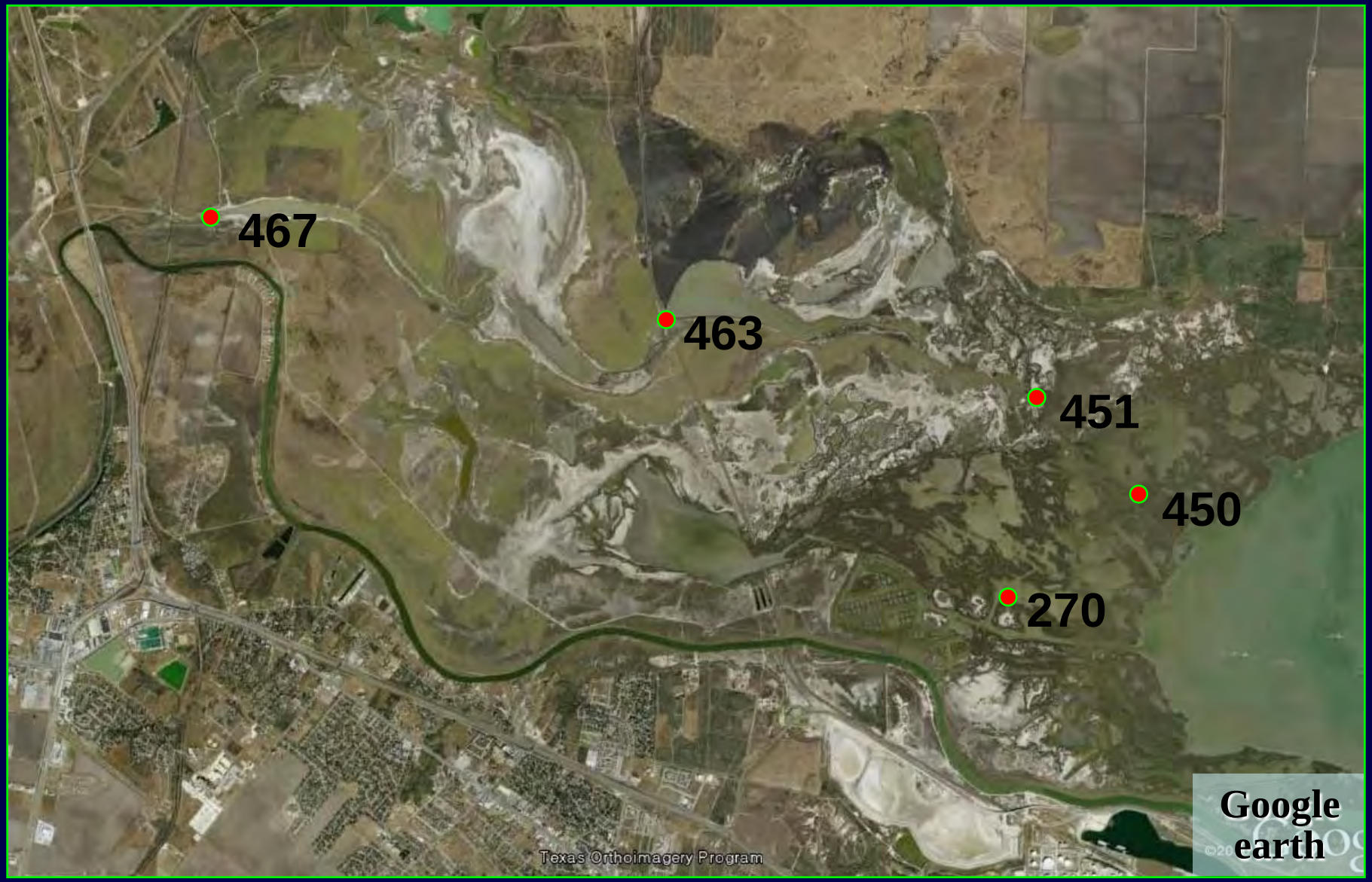
Photosynthetic responses to environmental stresses under natural conditions

Construct a carbon budget for the Nueces River Delta

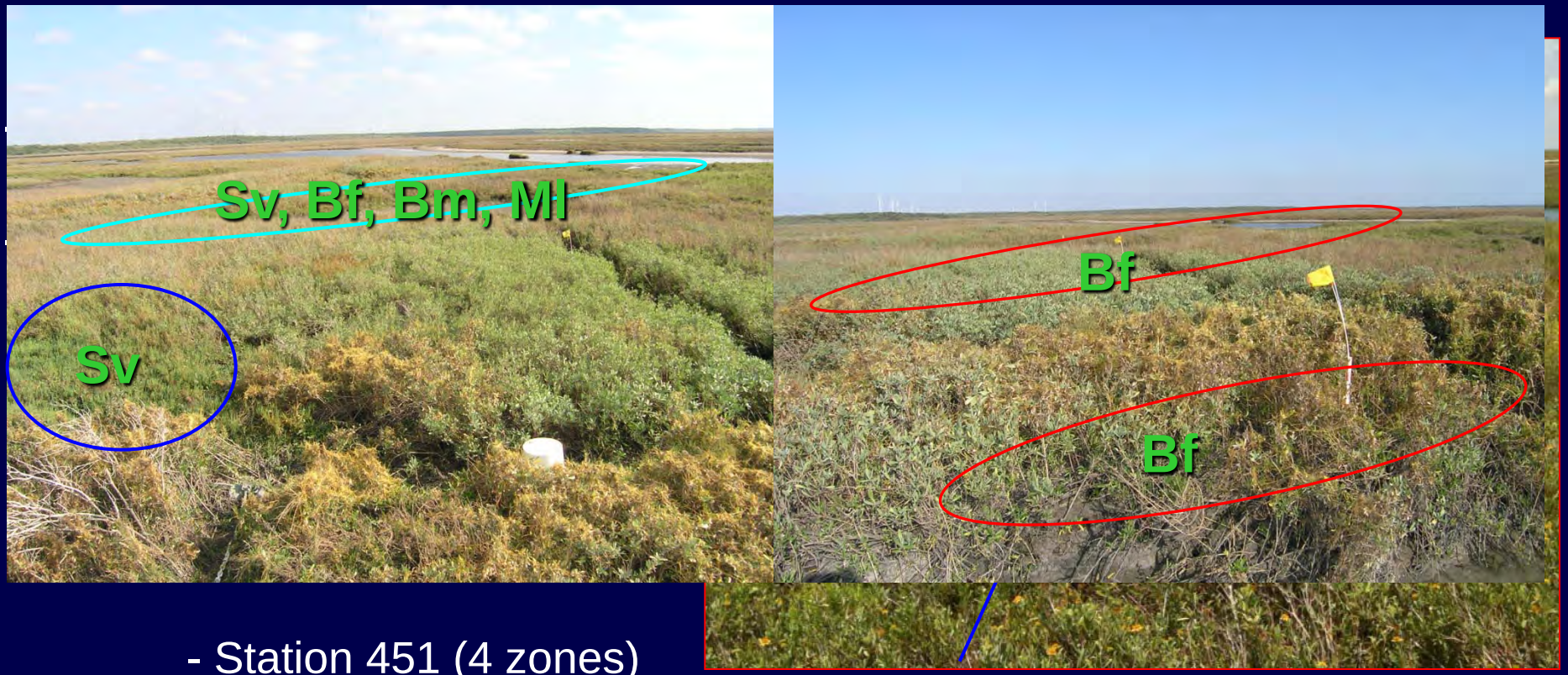
Hypothesis

The role of salt marsh as a net sink or source of CO_2 depends on season

Study sites


467
463
451
450
270
Texas Orthoimagery Program
Google earth

Experimental design



- Station 451 (4 zones)
- Two dominant *Borrichia furtescens* zones,
- One dominant *Salicornia virginica* zone and
- One mixed zone (*Borrichia frutescens, Salicornia virginica, Batis maritima, Monanthochloe littoralis*)

Data collection

Photosynthesis and respiration

- Using LI-6400 portable gas exchange system with conifer chamber

- Between 10:00 and 15:00

- For respiration, the chamber was shaded by a black plastic bag

Soil respiration

- Using LI-6400 portable gas exchange system with soil chamber at bare bed and inside canopy

Environmental factors

- Salinity, temperature and precipitation

Environmental factors

Temperature

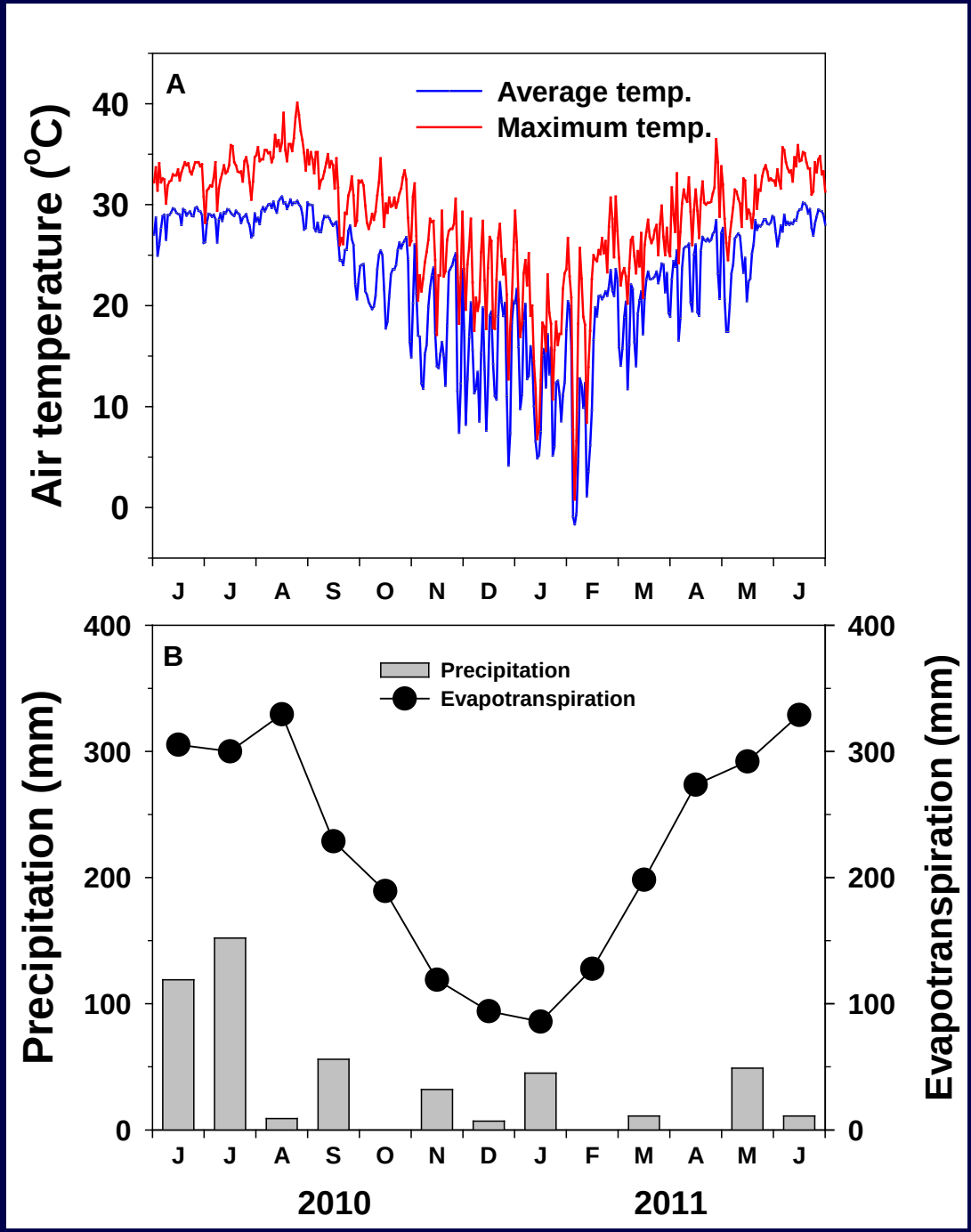
- Seasonal trend

Precipitation

- Very low

Evapotranspiration

- highest during summer
- lowest during fall-winter

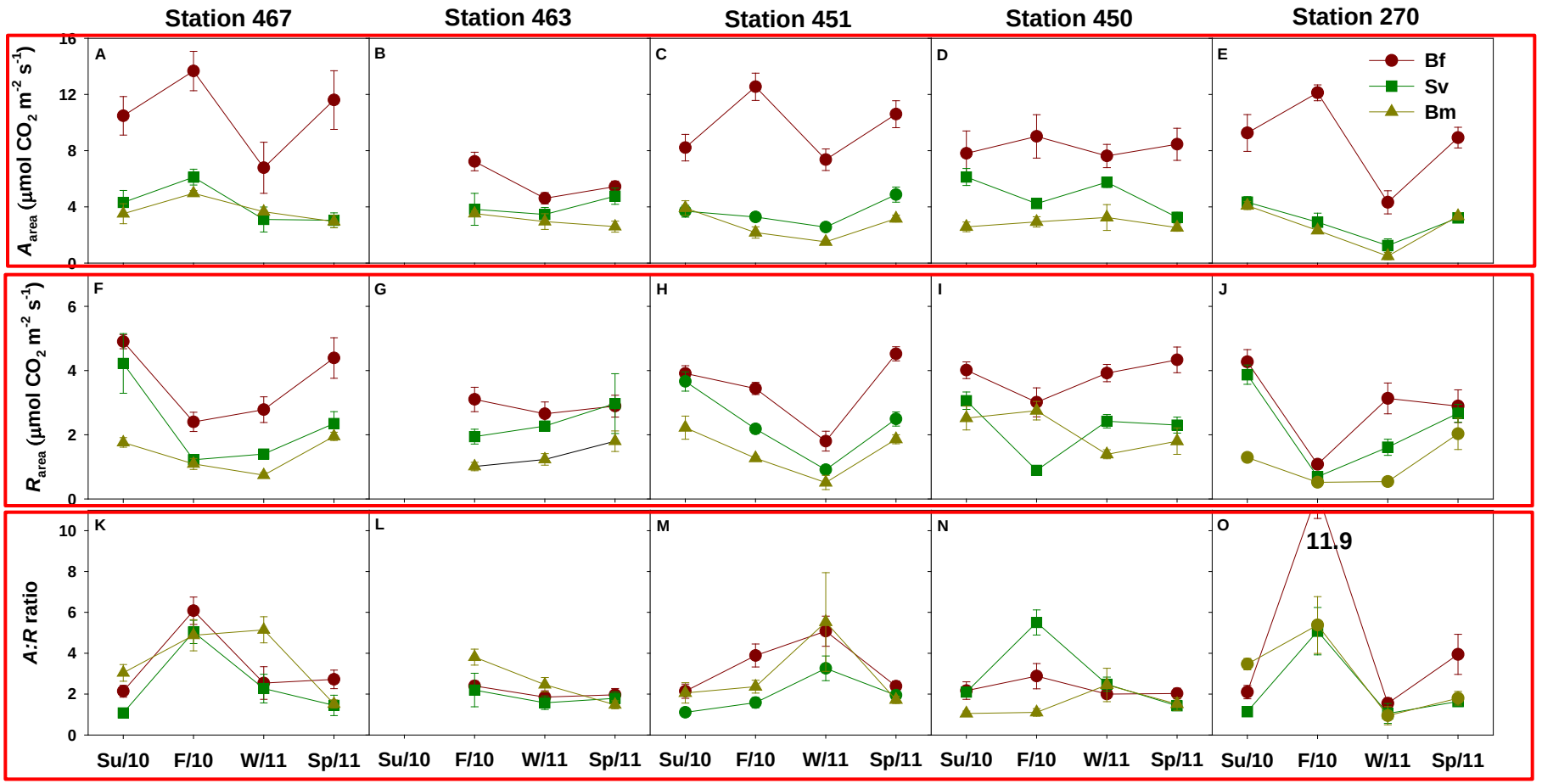


Salinity, moisture and nutrients

Parameters	Values
Salinity (PSU)	
Tidal creek	**4 – 35**
Porewater	**14 – 68**
Soil moisture (%)	**20 – 55**

* Range

Photosynthetic characteristics



*A_{area} – net photosynthesis; R_{area} – Respiration; Bf – *B. frutescens*; Sv – *S. virginica*; Bm – *B. maritima.*

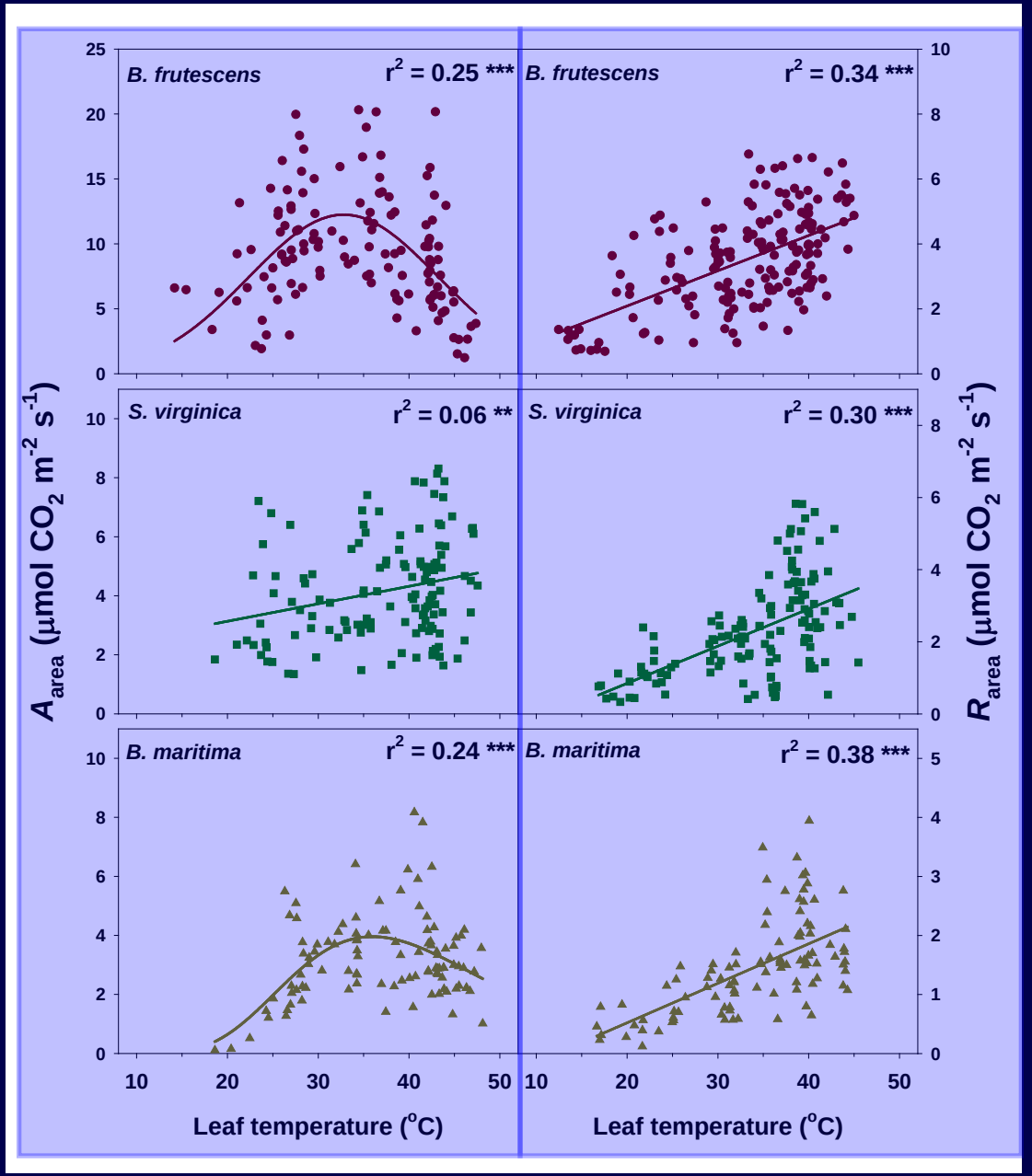
Relationships between temperature and *A*, *R*

Net photosynthesis

- Bf (28 – 35^{o}C)
- Bm (31 – 37^{o}C)

Respiration

- positive relationships



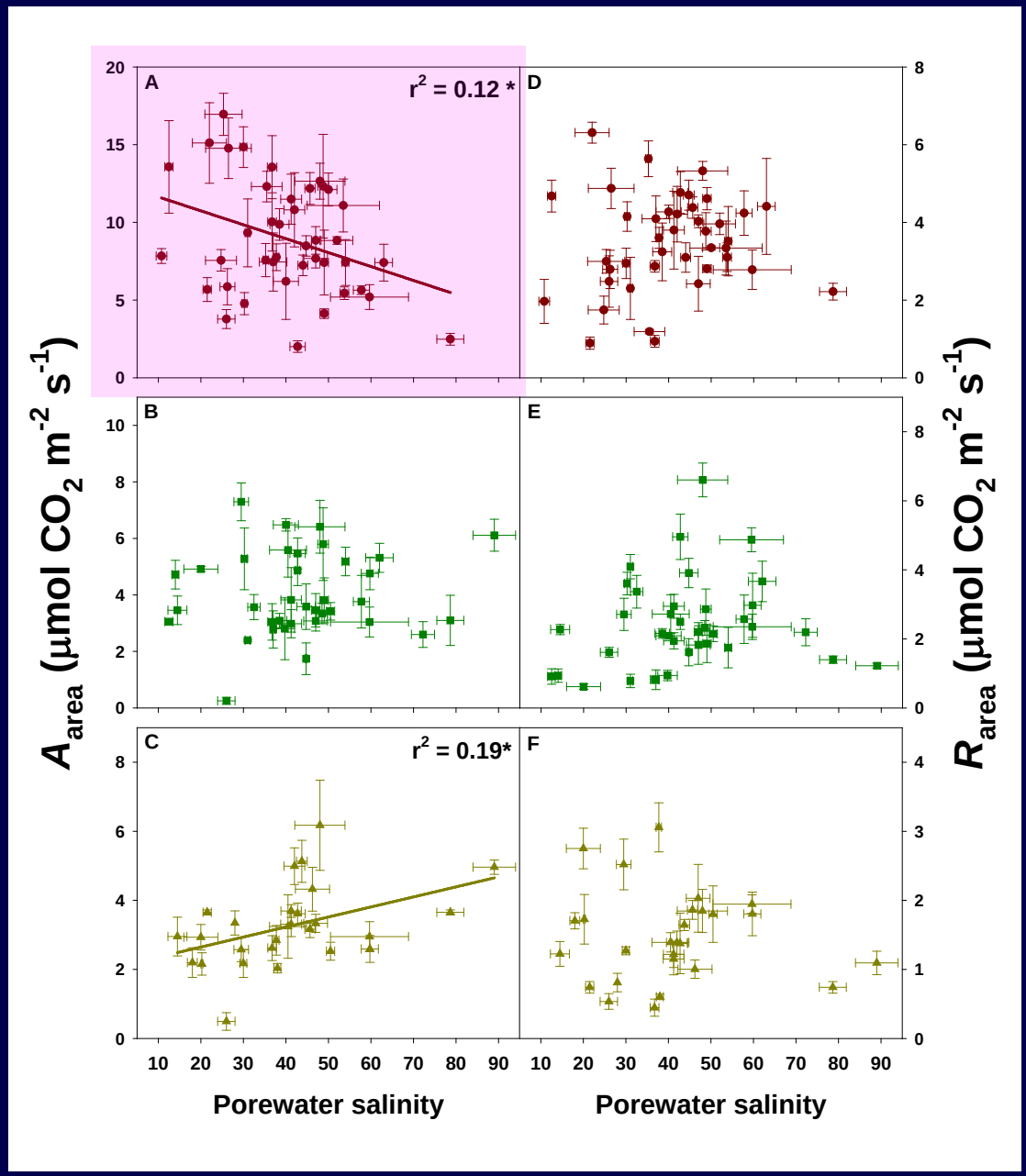
Relationships between porewater salinity and *A*, *R*

 # Borrichia frutescens

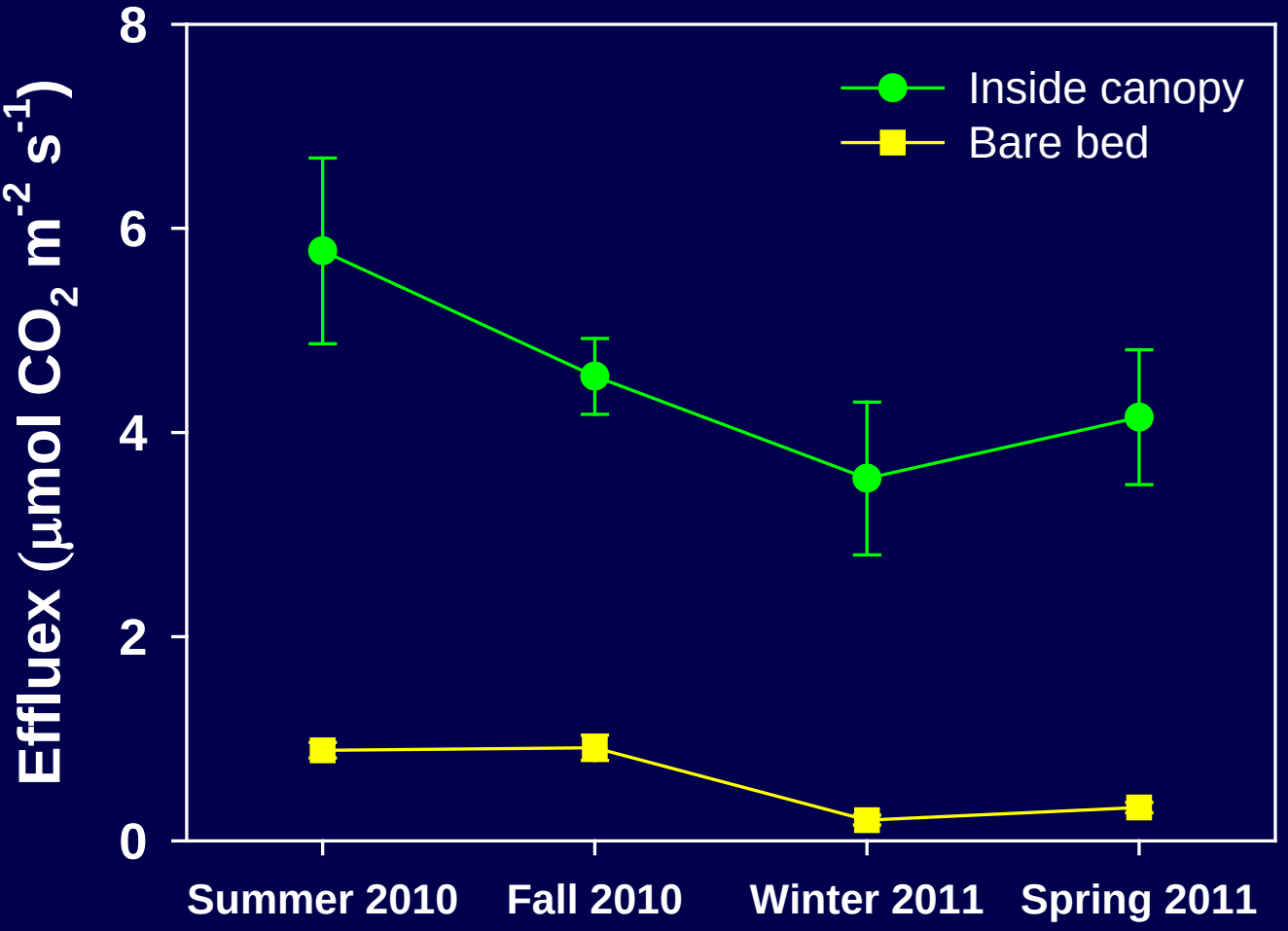
- Negative relationship

 # Batis maritima

- positive relationship



Soil respiration



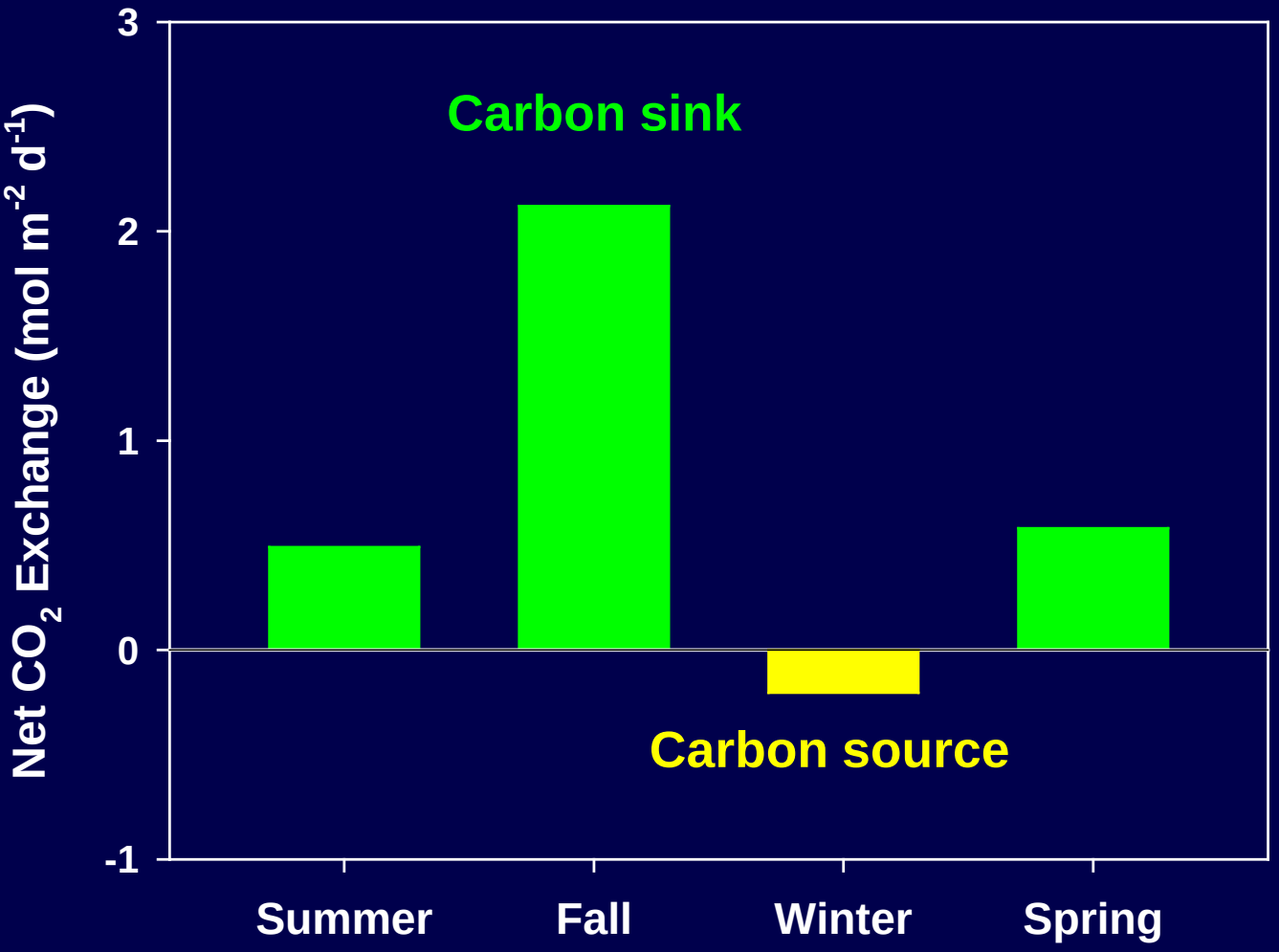
Carbon budget (calculation)

- Vegetation coverage data (P, 2007-2008) and biomass (B, 2010)
- Net photosynthesis (nmol g^{-1} DW s^{-1}, 10 h) and respiration (14 hour),
- Soil respiration (μmol CO^2 m^{-2} s^{-1}, 24 hour)
- Biomass per unit area (BU, g DW) = P (%) X P/B ratio (g DW / %)

Summer	Net Photo	BU	Mol CO_2 m^{-2} d^{-1}	Res	BU	Area (%)	Mol CO_2 m^{-2} d^{-1}
Batis maritima	69.4	43.3	0.108	19.9	43.3		0.043
B. frutescens	54.5	1222.8	2.399	26.5	1222.8		1.633
S. virginica	55.9	64.1	0.129	43.3	64.1		0.140
Soil respiration at bare bed	-	-	-	0.89		9.1	0.007
Soil respiration inside canopy	-	-	-	5.78		64.3	0.321
Total	**2.636**			**2.145**			

Station 270

Carbon budget



Conclusions

- Photosynthesis and respiration of plants
  - biomodal patterns and/or seasonal variations
- High temperature
  - inhibit or accelerate net photosynthesis or respiration
- Porewater salinity
  - Limitating factor of photosynthesis (*B. frutescens*)
- The role of salt marsh depends on season
  - Carbon sink (spring-fall) and carbon source (winter)

Further study

- Salt marsh network
  - North America and South Korea

- Blue carbon mapping in Korea
  - including seaweed and seagrasses

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Questions?