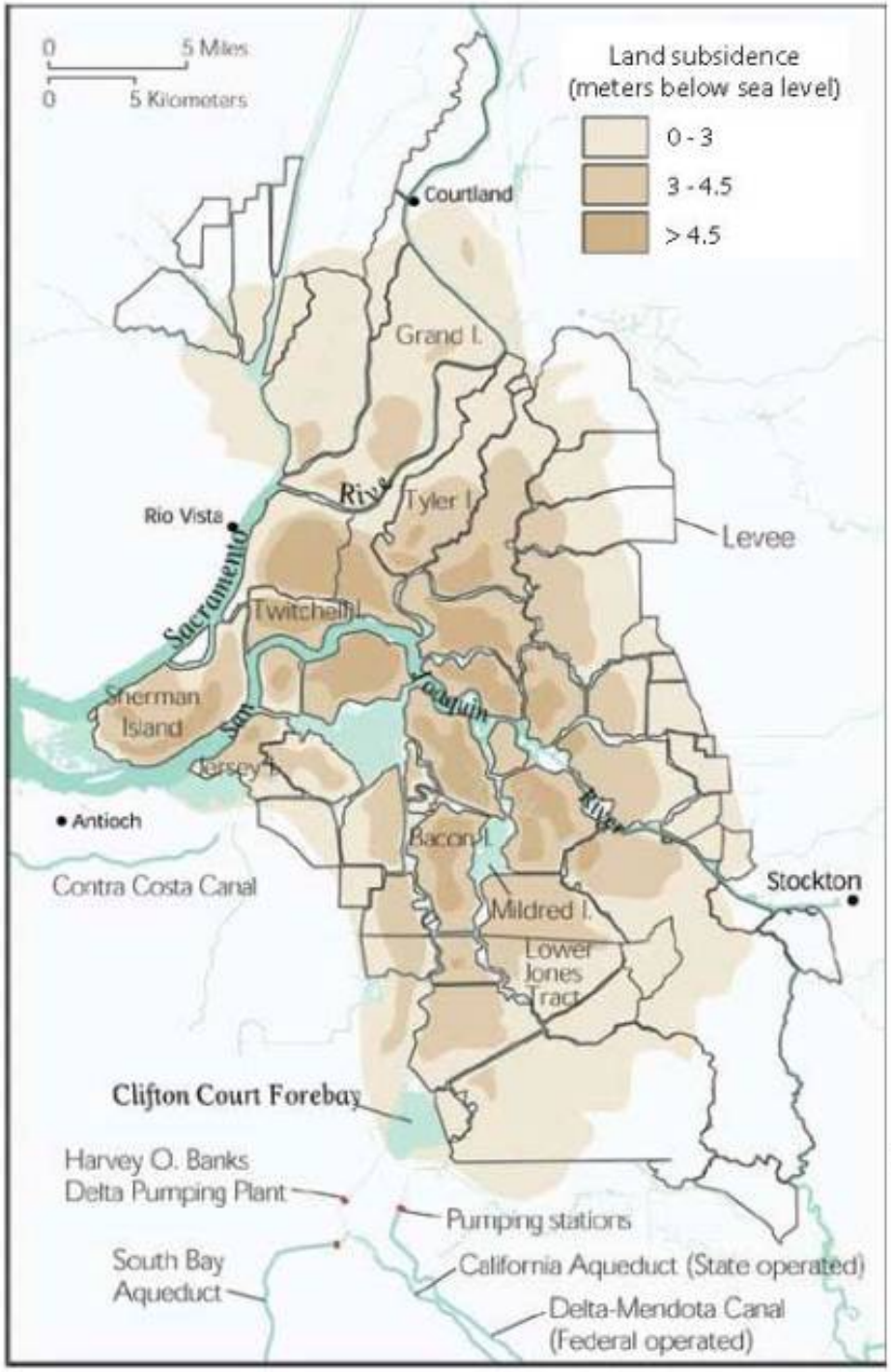
Plant biomass carbon inputs, losses, and storage in re-established marshes in the Sacramento-San Joaquin Delta

By Robin L. Miller



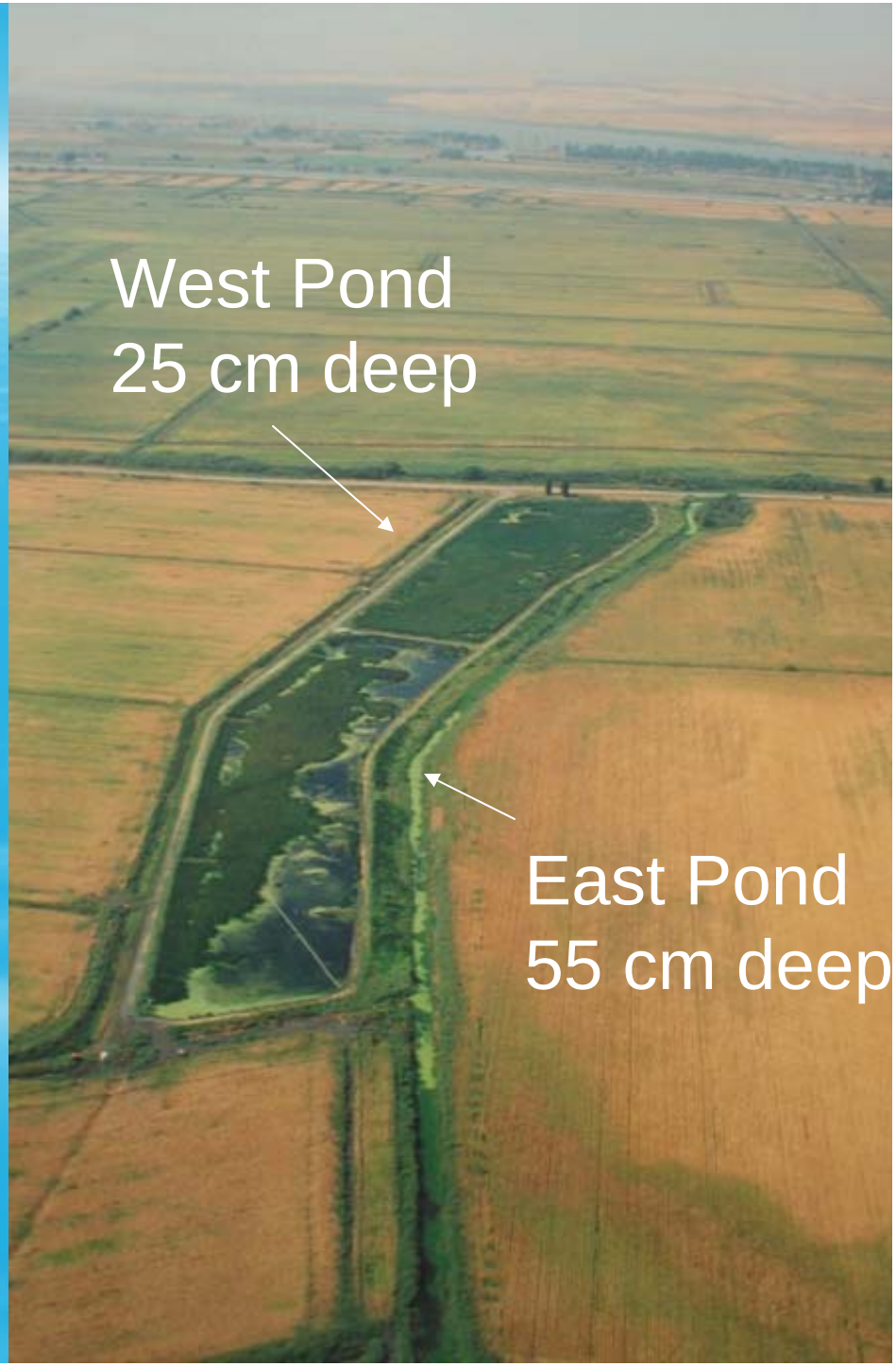
- Location of Sacramento-San Joaquin Delta in California and depth of subsidence

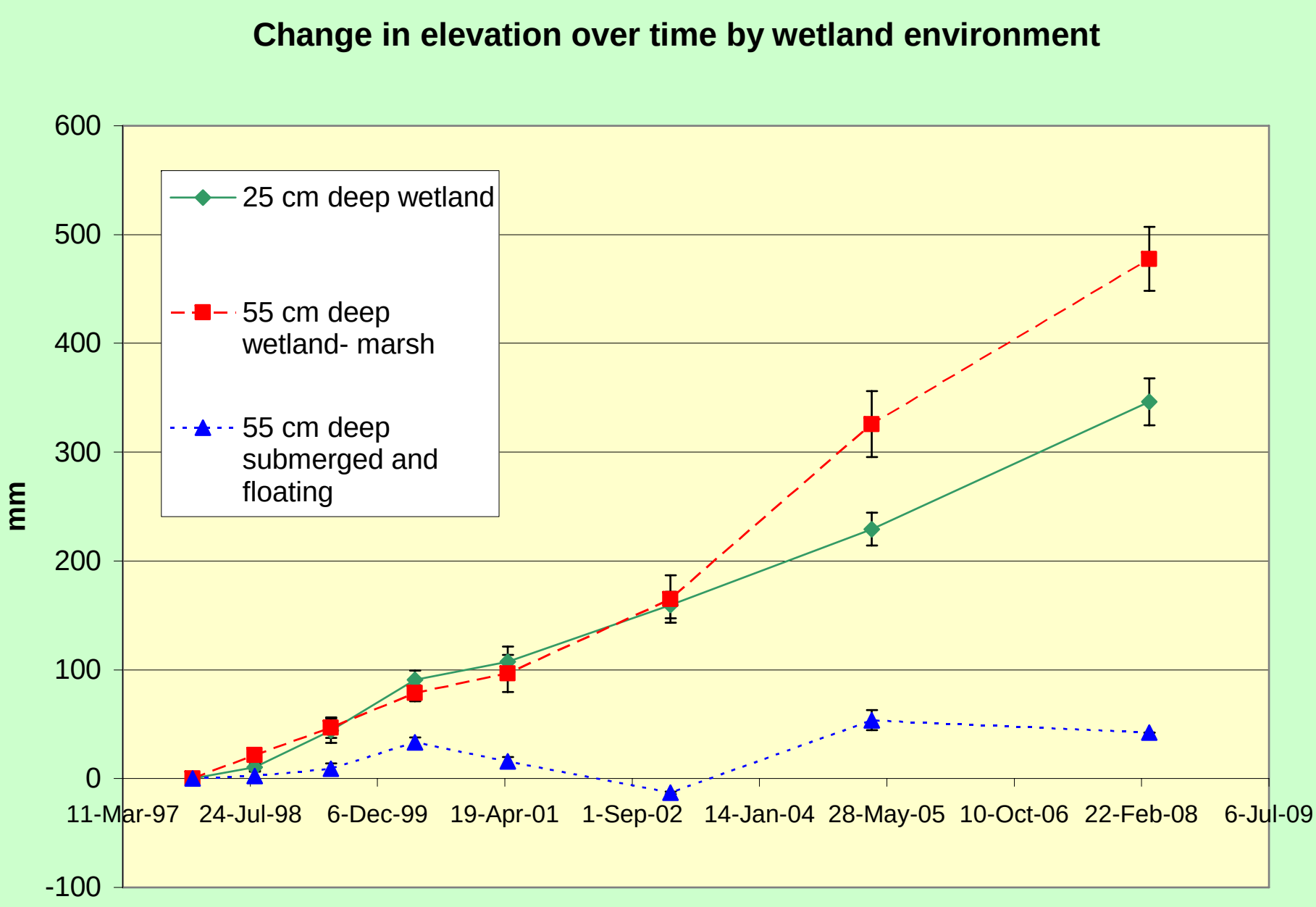
Demonstration Project 1997-present

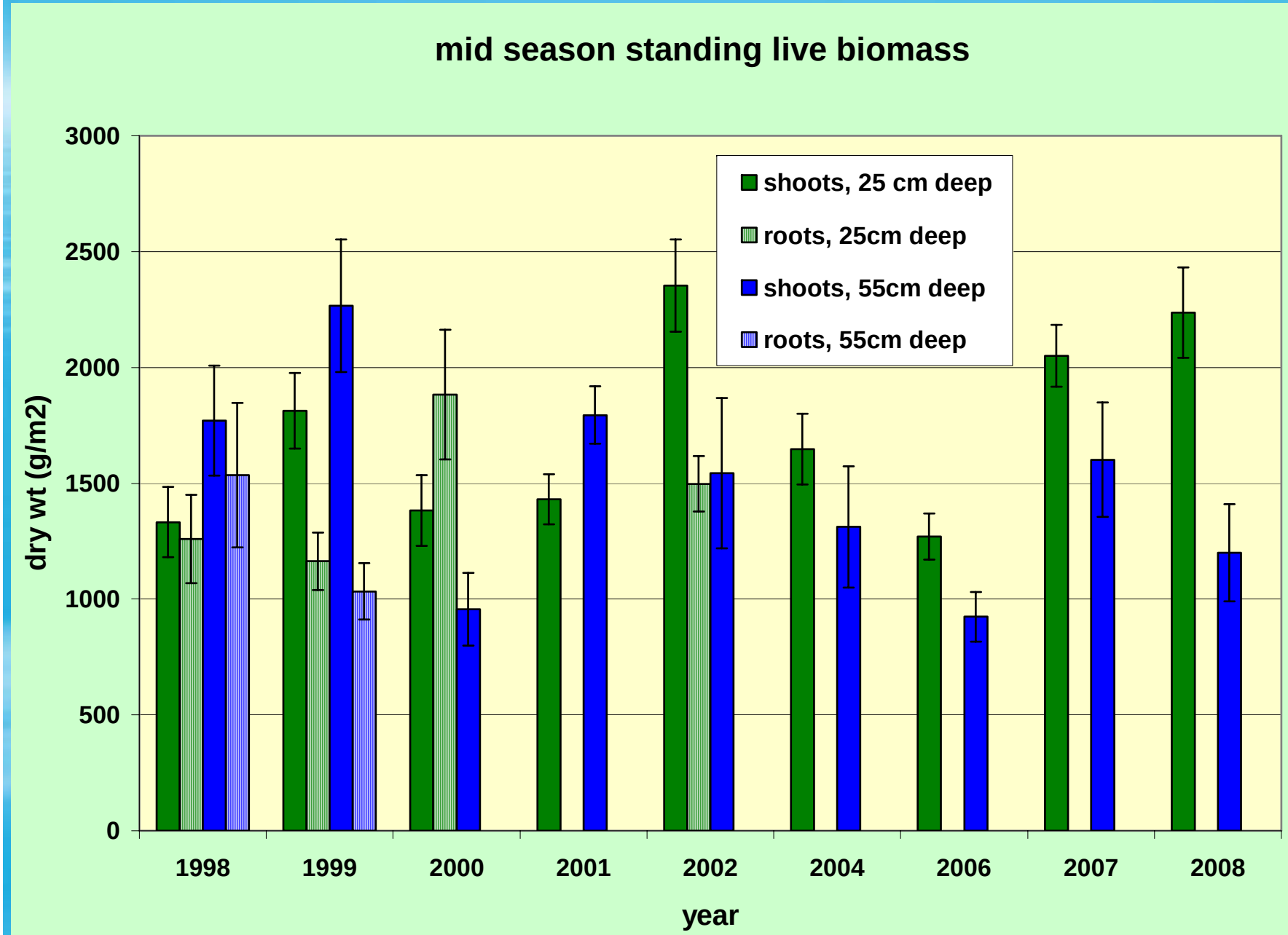
- Two 3 ha wetlands
- Continuously flooded
- Non-tidal system
- Water management

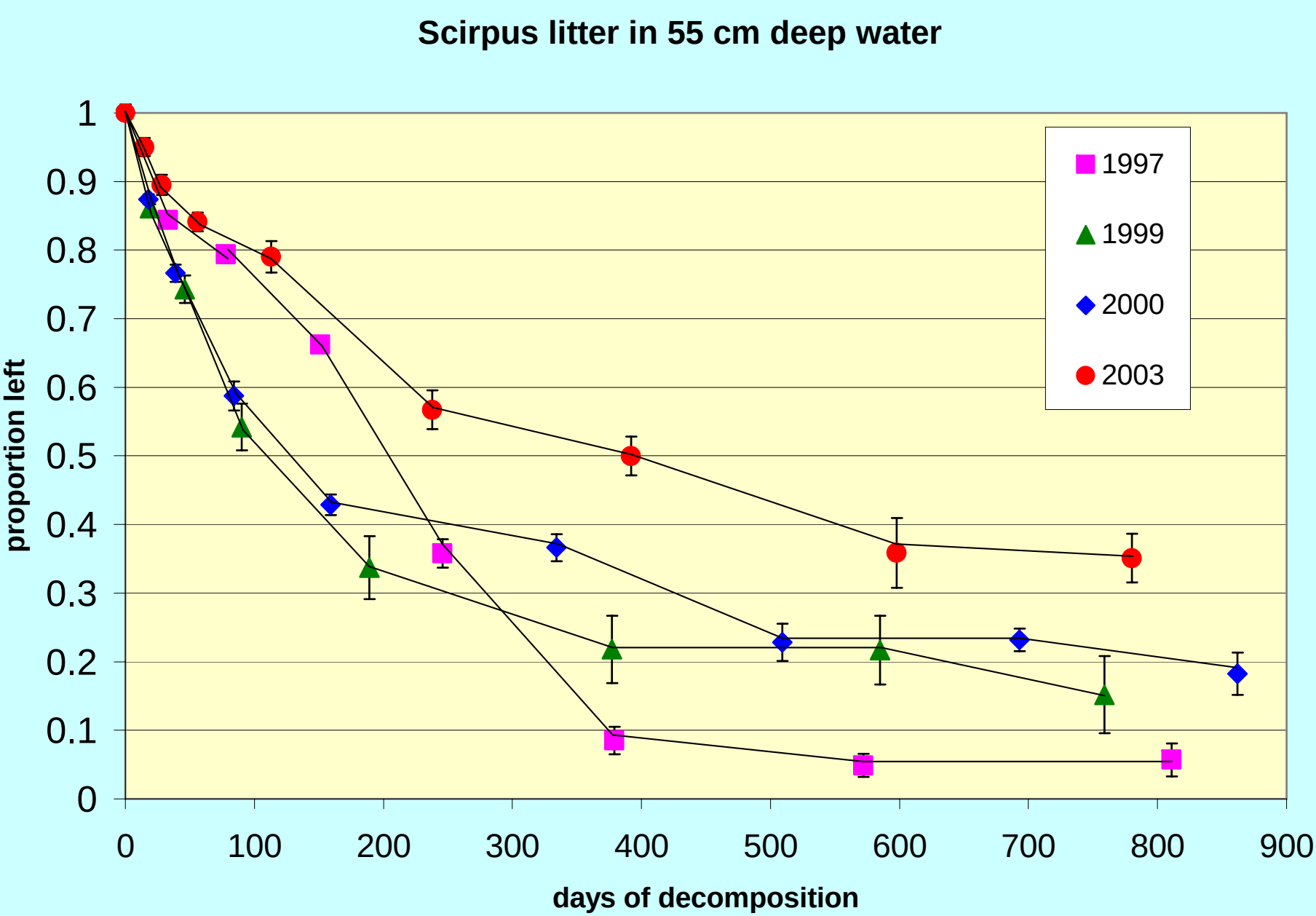
Measurements include
Land-surface elevation change and sediment accretion:

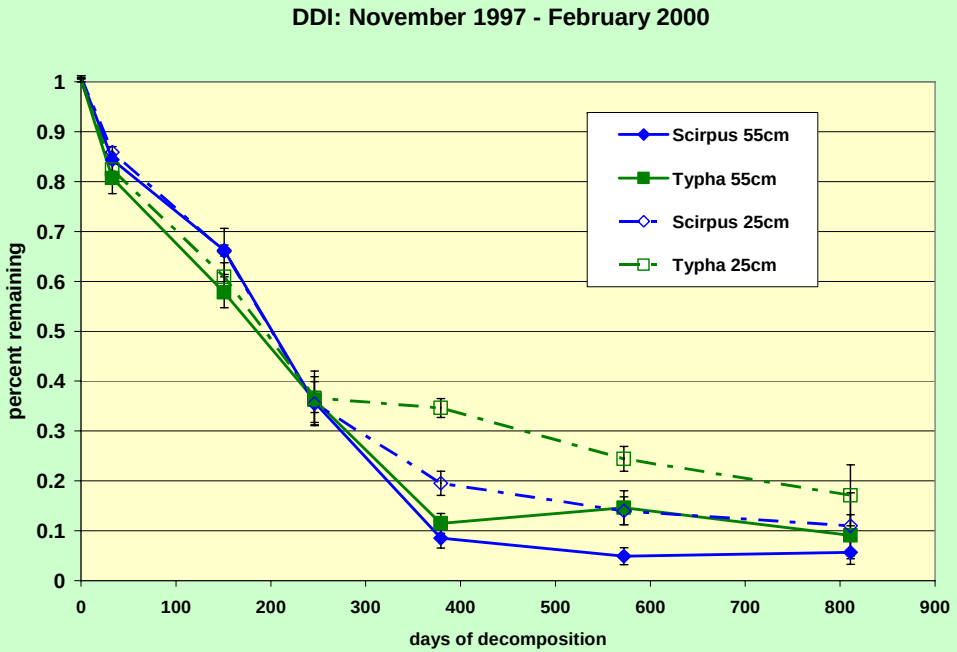
Plant biomass production
Decomposition of organic matter
Gaseous CO_2 and CH_4 fluxes
Environmental Factors (i.e. pH, temperature, dissolved oxygen, etc)

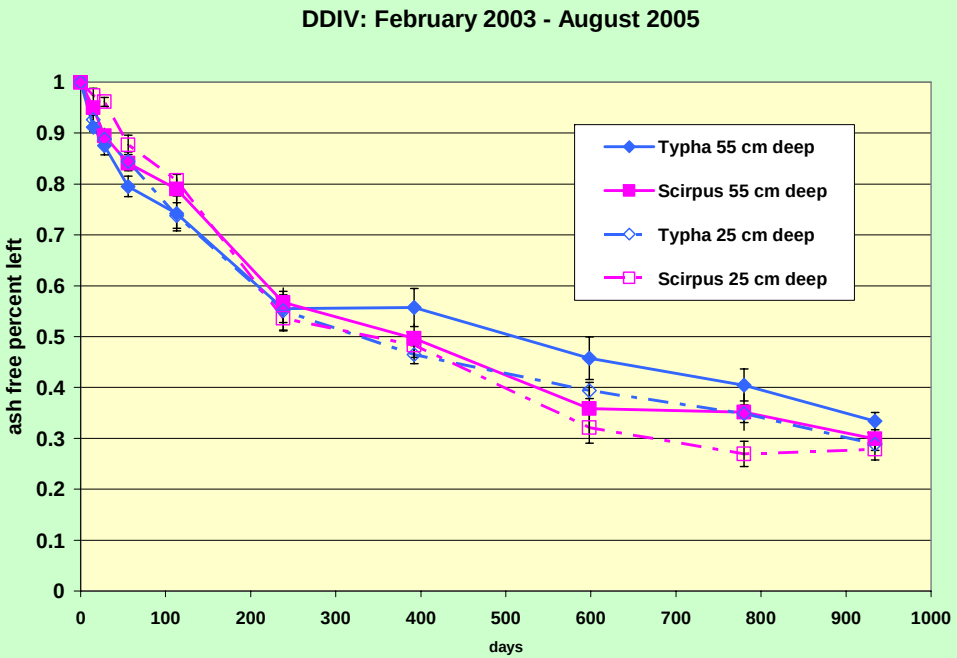



Change in elevation over time by wetland environment
mm
600
500
400
300
200
100
0
-100
11-Mar-97
24-Jul-98
6-Dec-99
19-Apr-01
1-Sep-02
14-Jan-04
28-May-05
10-Oct-06
22-Feb-08
6-Jul-09
25 cm deep wetland
55 cm deep wetland- marsh
55 cm deep submerged and floating


mid season standing live biomass
3000
2500
2000
1500
1000
500
0
dry wt (g/m2)
shoots, 25 cm deep
roots, 25cm deep
shoots, 55cm deep
roots, 55cm deep
1998
1999
2000
2001
2002
2004
2006
2007
2008
year


Scirpus litter in 55 cm deep water
proportion left
days of decomposition
1997
1999
2000
2003
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
100
200
300
400
500
600
700
800
900

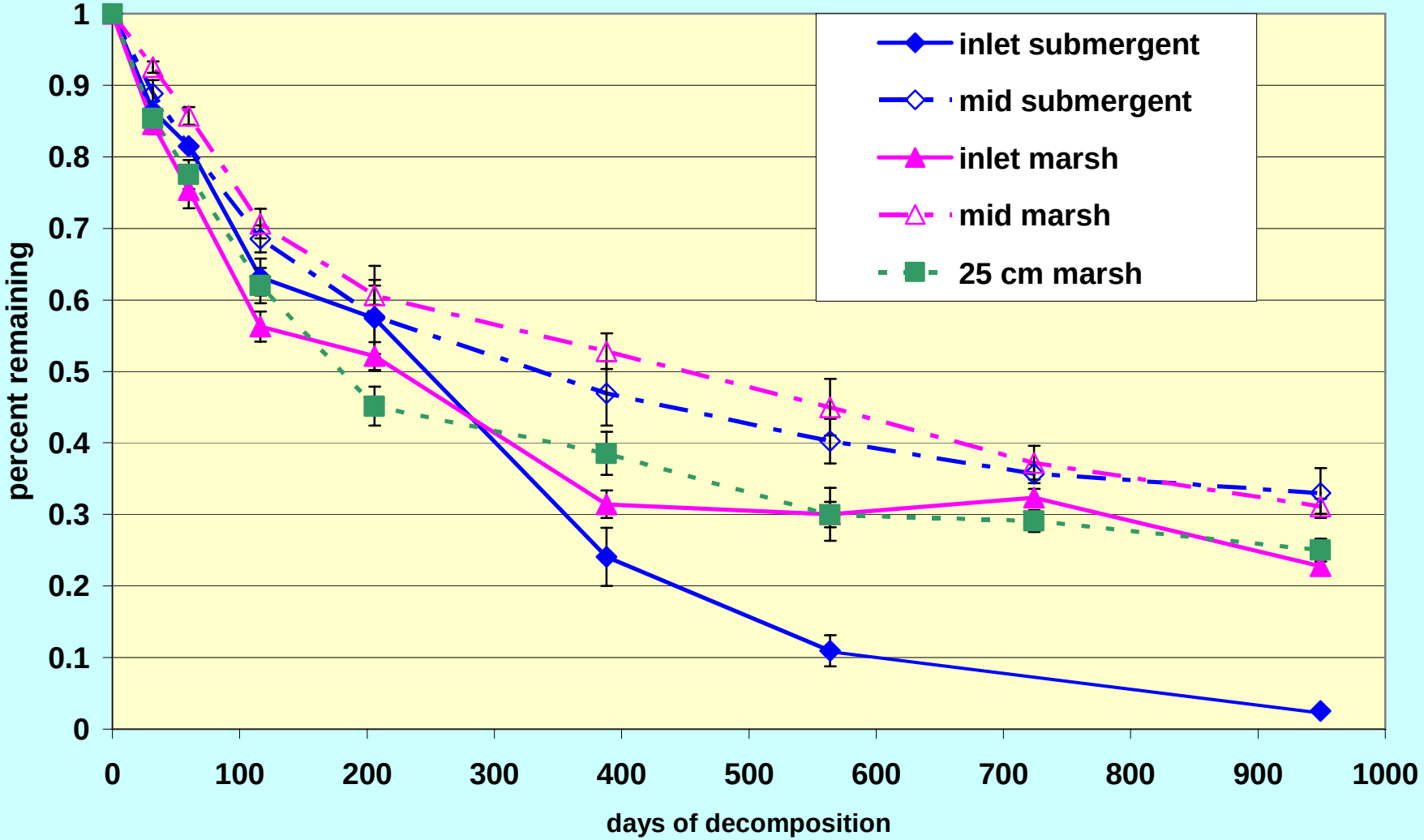


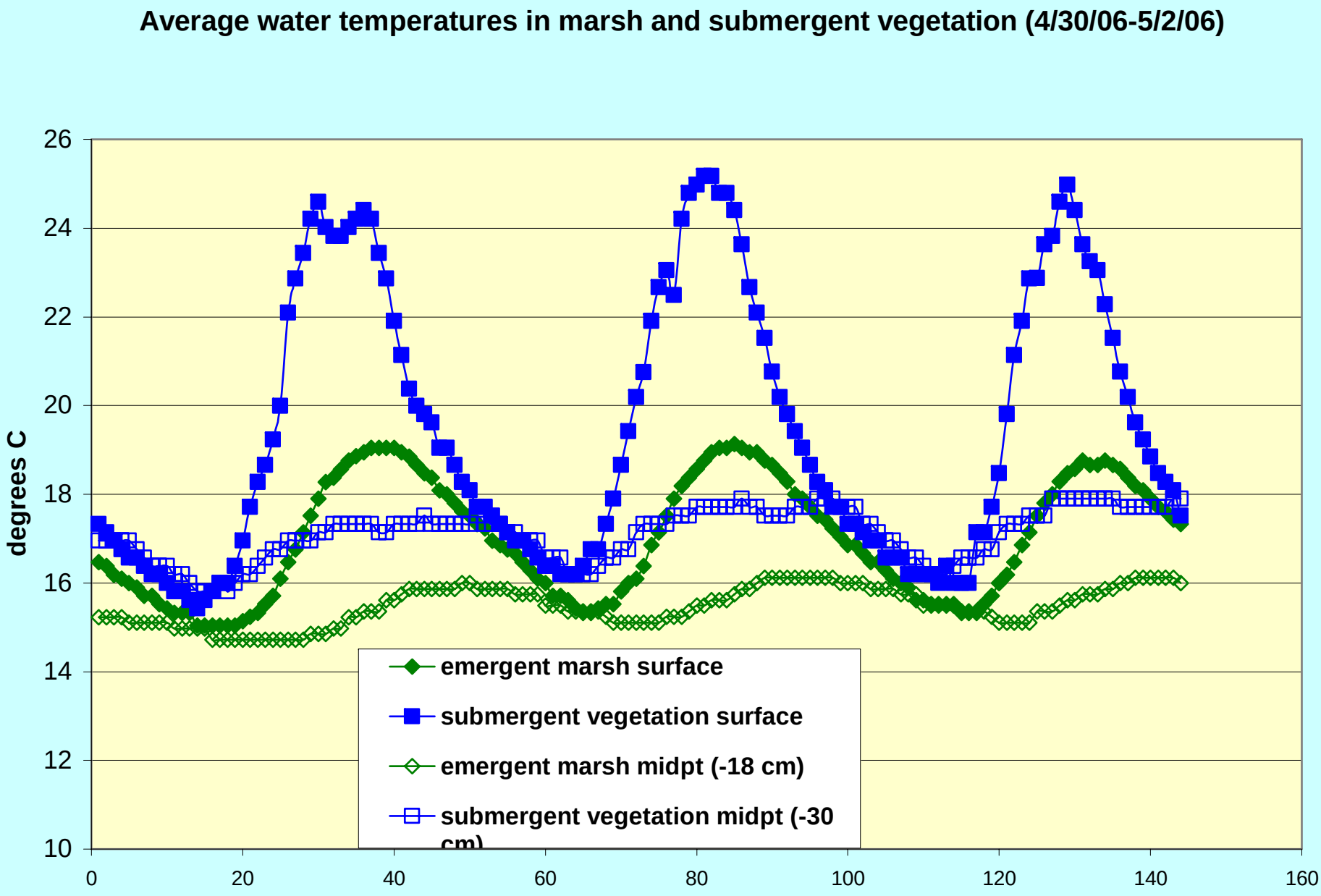


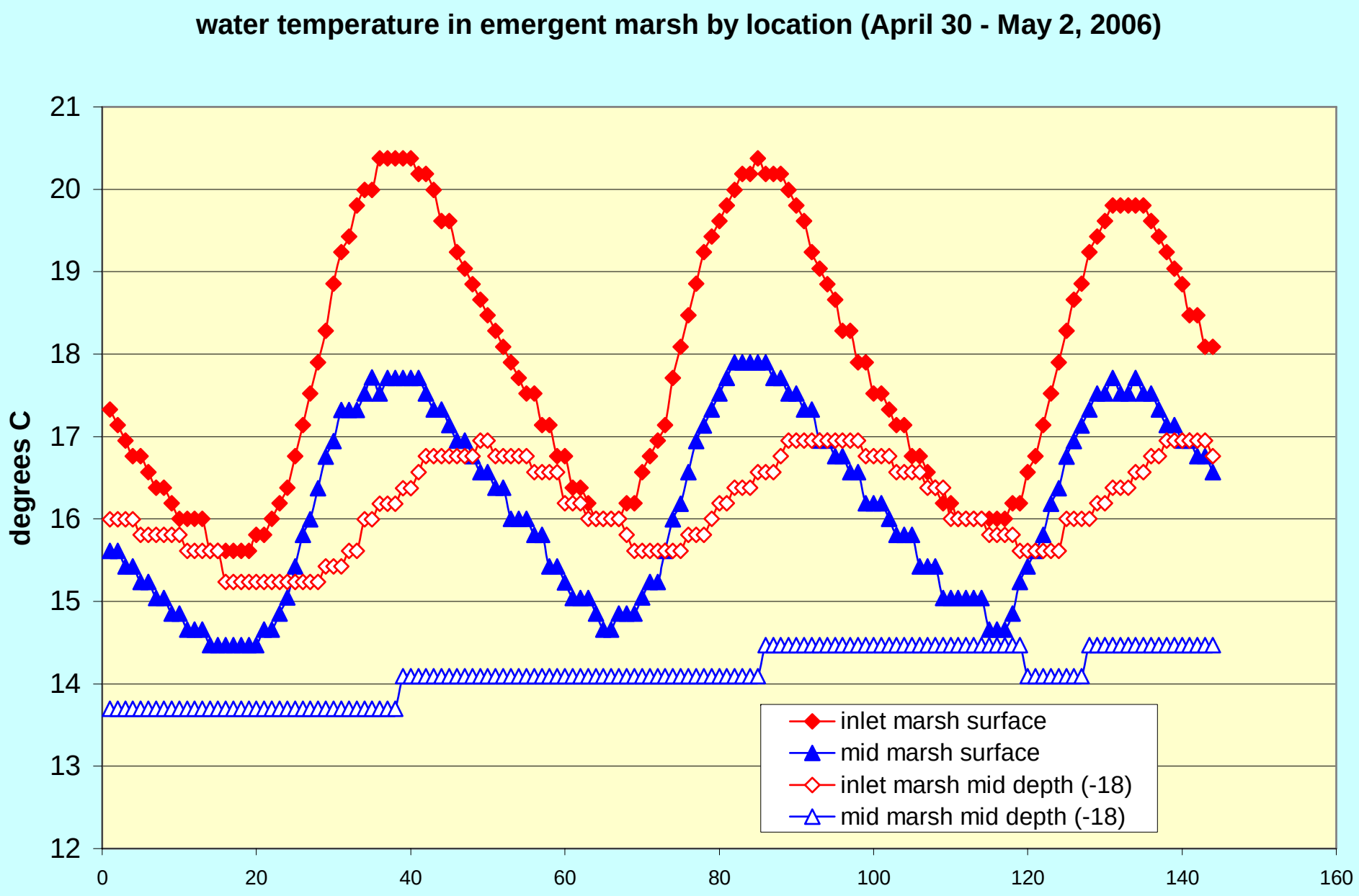
- Decomposition rates slowed over time.
- Early decomposition was slower in the 25 cm deep wetland.
- Later decomposition was slower in the 55 cm deep wetland.

DDV: Location of decomposition bags in the 55 cm deep wetland

DDV: Scirpus decomposition by location and vegetation




Average water temperatures in marsh and submergent vegetation (4/30/06-5/2/06)
degrees C
26
24
22
20
18
16
14
12
10
0
20
40
60
80
100
120
140
160
emergent marsh surface
submergent vegetation surface
emergent marsh midpt (-18 cm)
submergent vegetation midpt (-30 cm)


water temperature in emergent marsh by location (April 30 - May 2, 2006)
degrees C
21
20
19
18
17
16
15
14
13
12
0
20
40
60
80
100
120
140
160
inlet marsh surface
mid marsh surface
inlet marsh mid depth (-18)
mid marsh mid depth (-18)

Spatial variability in wetland environments

	Submergent Vegetation	Emergent Marsh Edge	Emergent Marsh Interior
Water residence time	Shortest	Mid	Longest
Water Temperature	Warmest	Cooler	Coolest
pH	Highest	Lower	Lowest
Dissolved Oxygen	Highest	Lower	Lowest
NO3 (river source)	Available	Absent/Available	Absent
SO4 (river source)	Available	Available	Depleted/Absent
H2S	Absent	Elevated/Absent	Absent/Increased
Fe (sediment source)	Low	Low/Increased	Elevated
Decomposition rate	Fastest	Slowed	Slowest

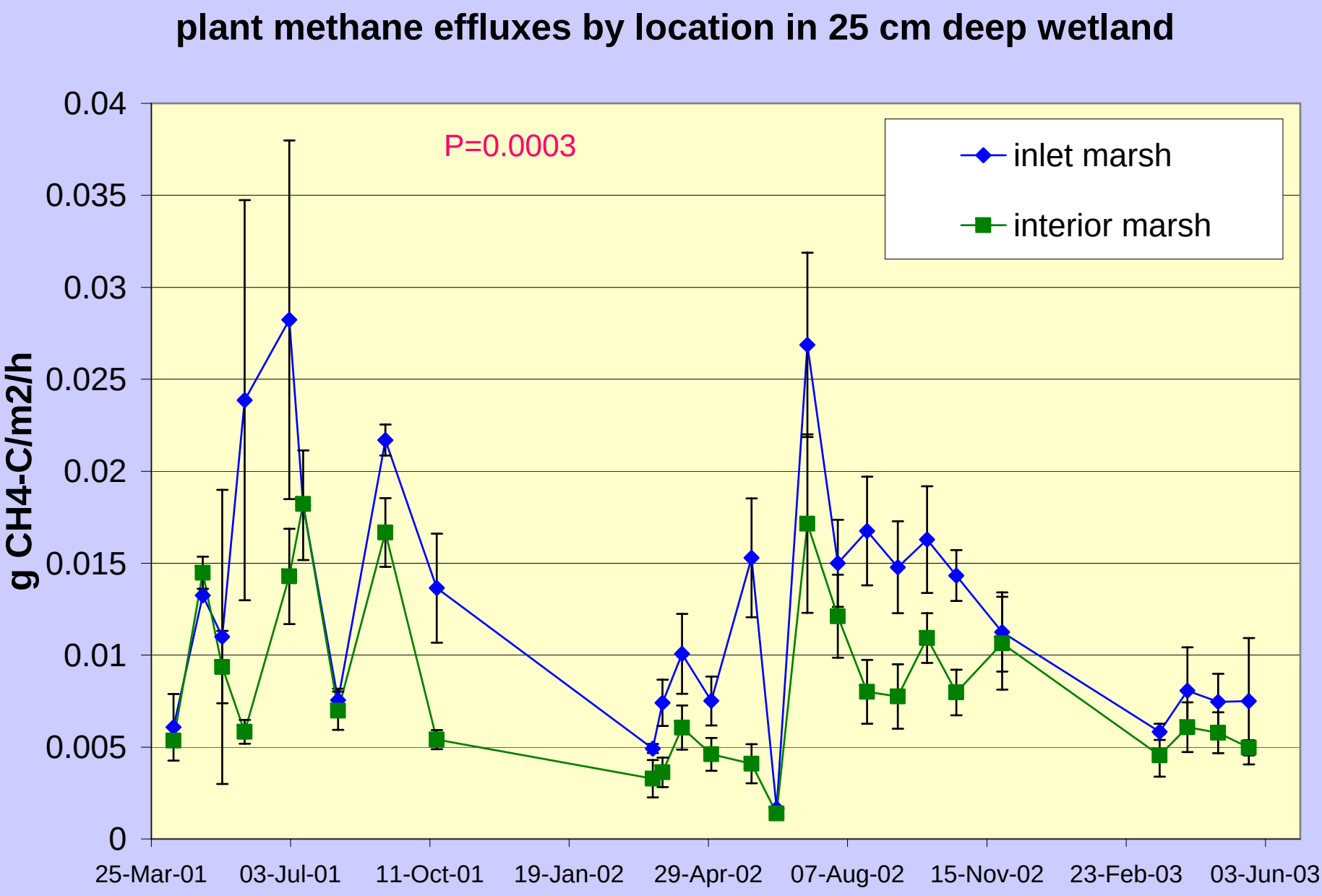
Correlations among wetland environmental factors ($p<0.0001$)

A	B	Cor-relation	Co-efficient
pH	DO	positive	0.755
NO_3	DO	positive	0.533
SO_4	Total Fe	negative	-0.467
pH	SO_4	positive	0.454
pH	Total Fe	negative	-0.395

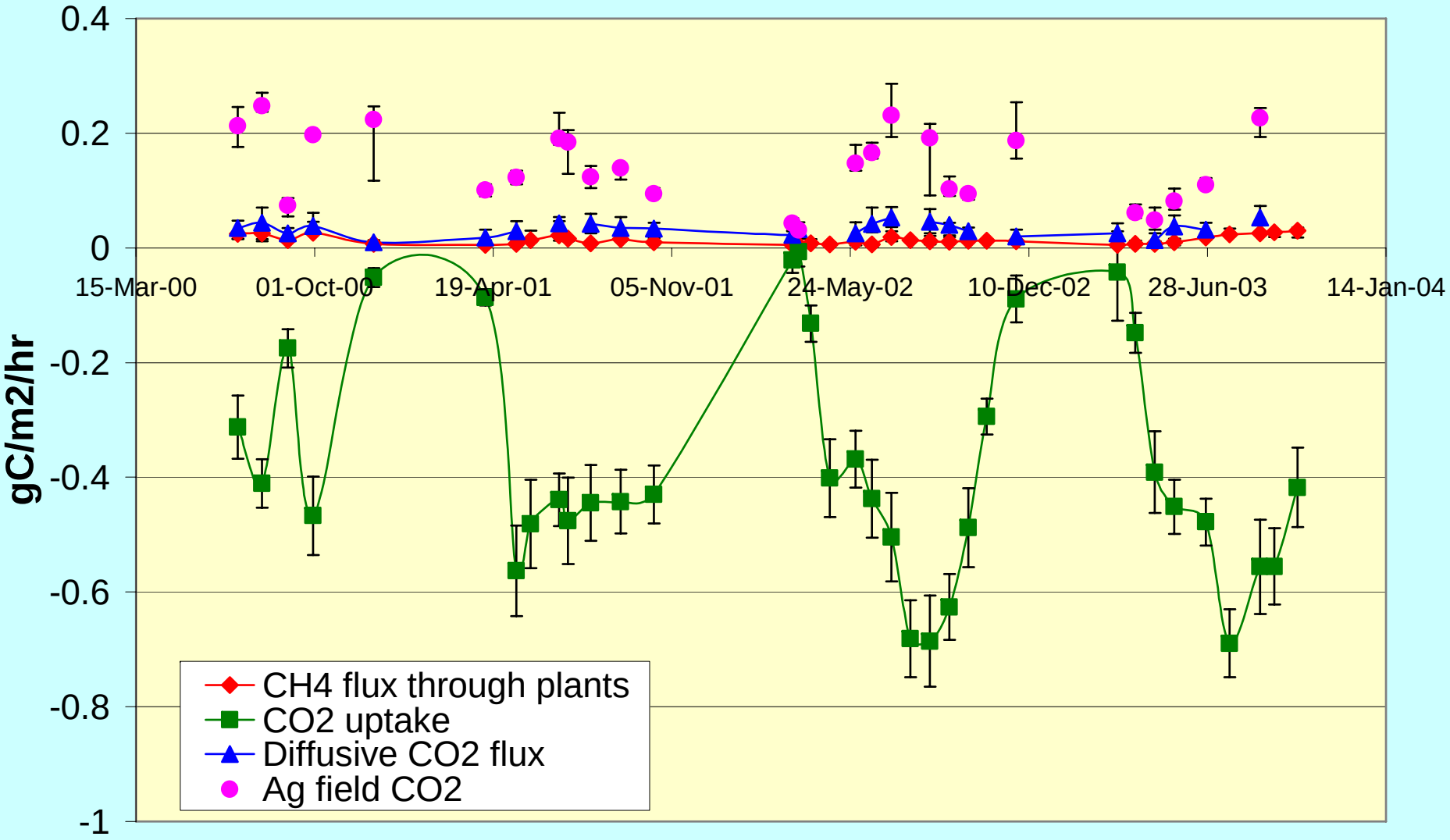
- pH indicative of relative wetland biogeochemistry
- 25 cm deep wetland had lower pH than the 55 cm deep wetland, but more sulfate and less iron.
- Shorter water residence time in shallower wetland influencing biogeochemistry; river water source of sulfate to wetlands.

pH and methane emissions

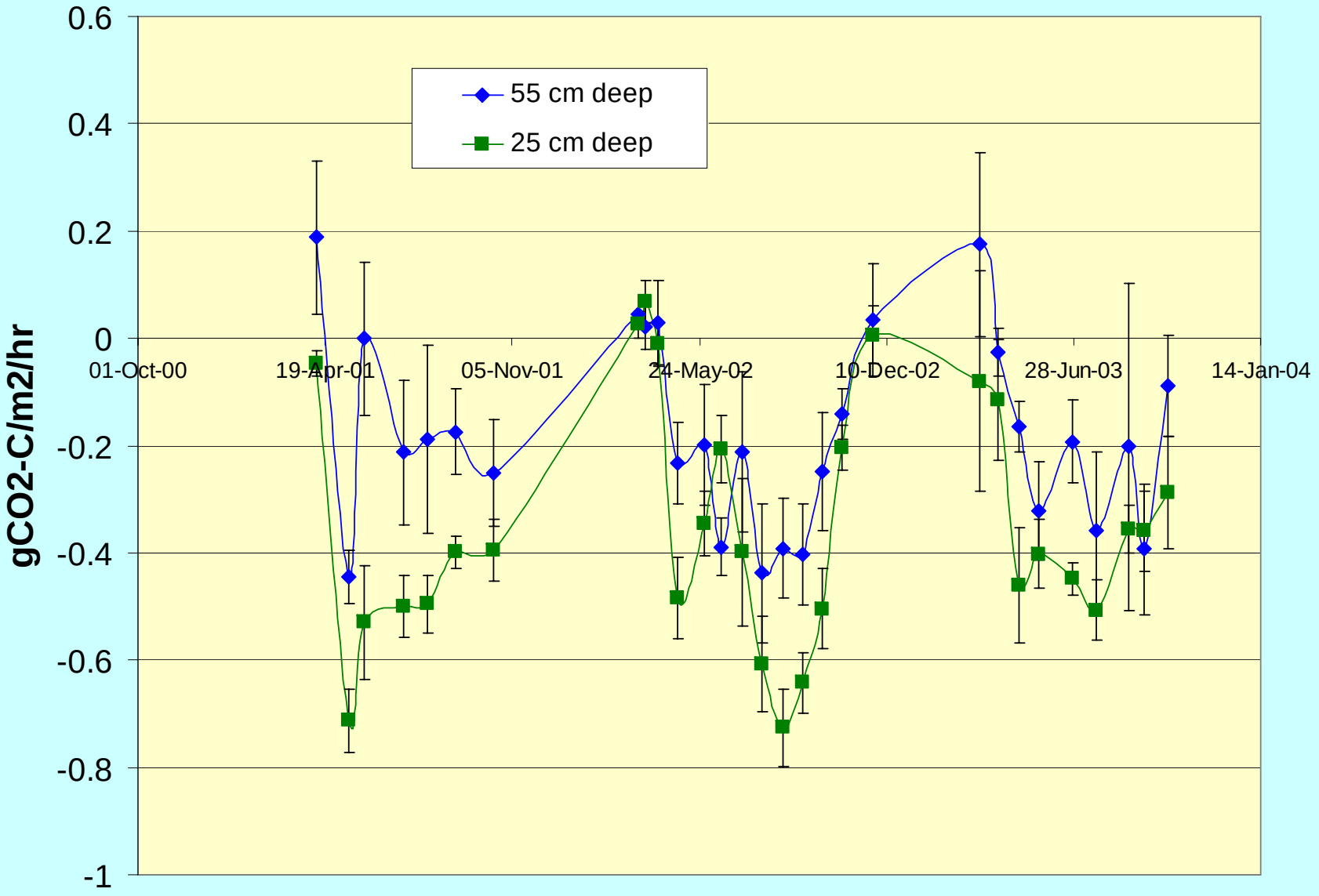
- Marsh CH_4 emissions are positively correlated to pH (coefficient = 0.333, only temperature, water depth and season stronger).
- Wetland pH correlated to CO_2:CH_4, such that lower pH decreases CH_4 loss relative to CO_2 uptake (coefficient = 0.354, only water depth and plant number stronger)


plant methane effluxes by location in 25 cm deep wetland
P=0.0003
inlet marsh
interior marsh
g CH4-C/m2/h
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
25-Mar-01
03-Jul-01
11-Oct-01
19-Jan-02
29-Apr-02
07-Aug-02
15-Nov-02
23-Feb-03
03-Jun-03

Gaseous C fluxes in re-established wetlands and drained peat



Greenhouse gas balance of CO2 uptake and CH4 loss in wetlands, where CH4 has 25x the GWP of CO2



Conclusions

- Re-establishing marshes in the Delta can restore conditions for carbon storage and reverse subsidence.
- The plant community significantly affected the wetland environment and accretion rates.
- Decomposition rates of marsh vegetation slowed over time, and differed by location with the slowest decomposition occurring in the marsh interior, where water residence time was greatest.
- Wetland pH significantly decreased over time, was significantly related to decomposition rates, and was strongly correlated to methane emissions and the availability of electron acceptors, including DO, NO_3, SO_4, and Fe.
- Methane emissions affect the GHG balance of marshes, but spatial variability suggests hydrologic management potential.
- Measurements of gaseous C fluxes suggest the carbon storage potential of these wetlands can counterbalance the effects of methane losses, particularly when stop loss of CO_2 and N_2O* from drained peat is taken into account.

Thank you!

- Great thanks to the California Department of Water Resources for funding this research.
- Many thanks to the many hands that have helped with this study.