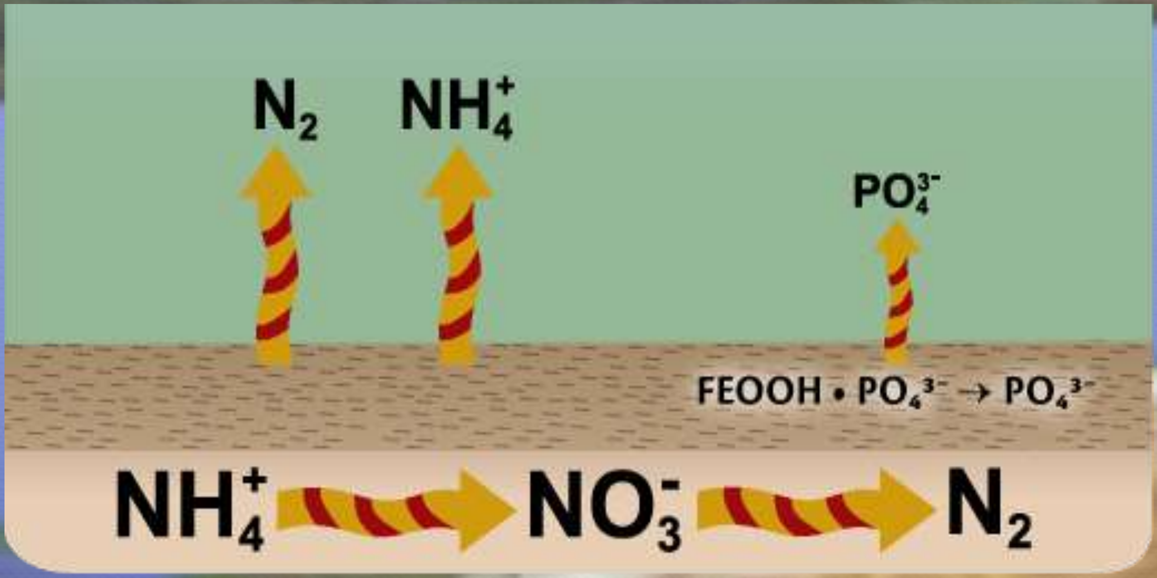
Biogeochemical Fluxes in Bay-Delta Sediments: Seasonal and Spatial Synthesis

Jeffrey C. Cornwell, Patricia M. Glibert,

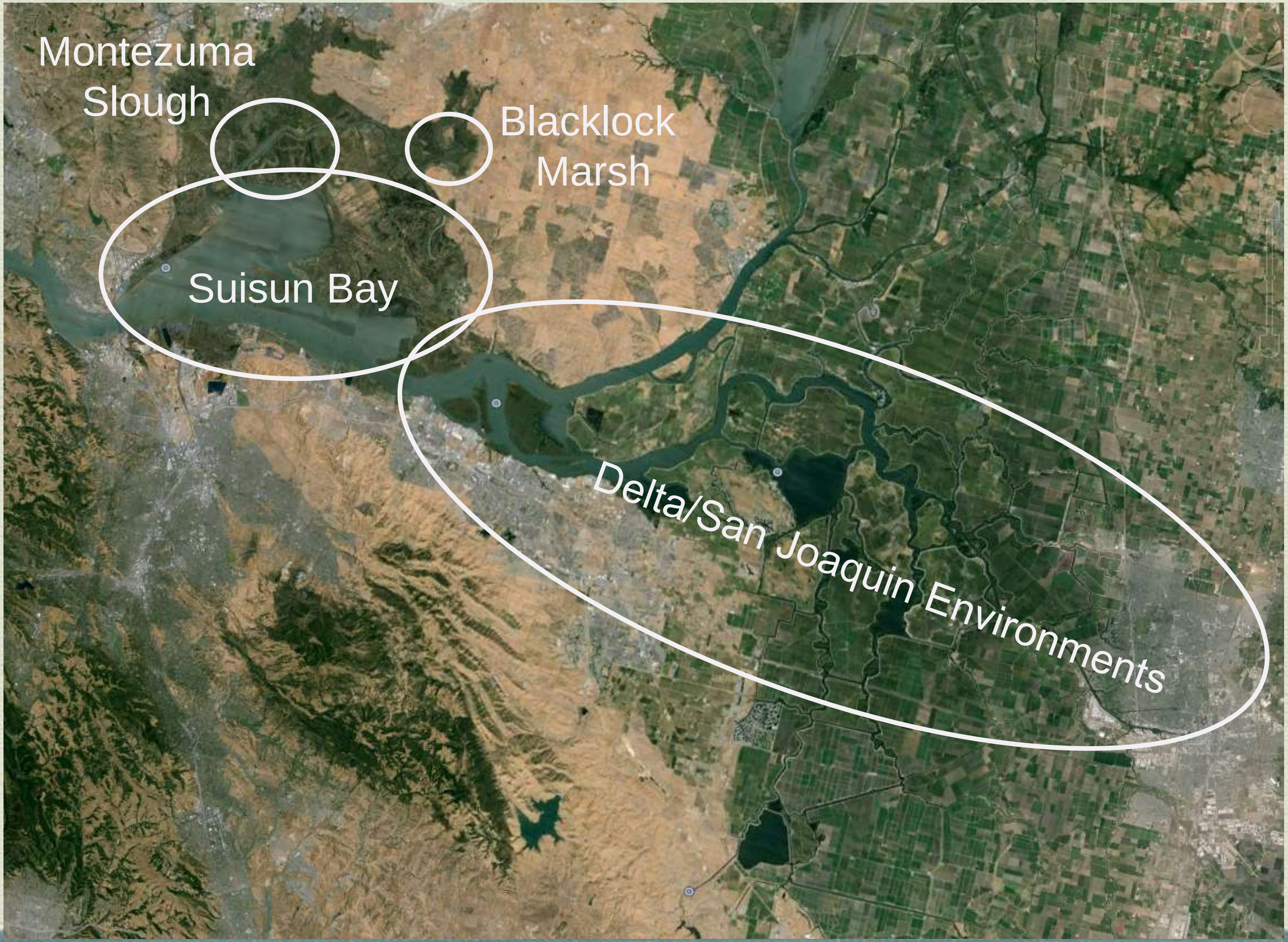
Michael Owens, Jeffrey Alexander

Key questions: What are the stores in, and fluxes of nutrients in and out of the sediments? How do they vary with site, season, as well as changes in environmental parameters- including salinity, benthic fauna, flora, etc?

Hypothesis: Sediments are important stores of nutrients and contribute to water column nutrient availability and site-specific differences in nutrient stoichiometry.



Study Domain



Transects from delta to bay

Experimental manipulations involving
variable salinity,
animals, pH

Results of first 2 sampling published in 2014

Estuaries and Coasts
DOI 10.1007/s12237-013-9755-4

Nutrient Fluxes from Sediments in the San Francisco Bay Delta

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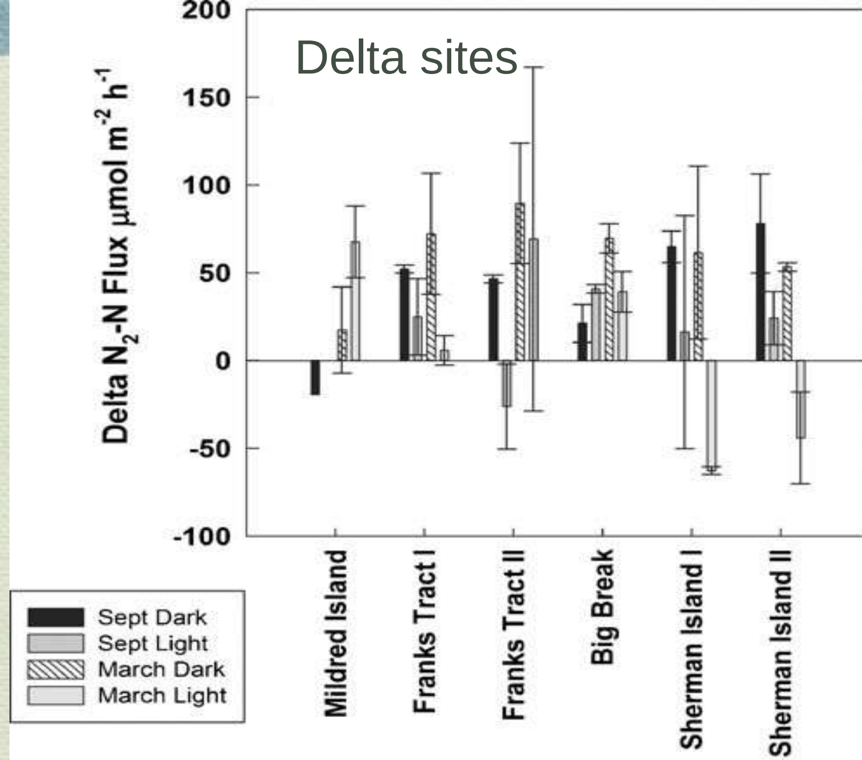
Experimental Approach

- Cores were collected with a HAPS box corer and by a pole mounted corer (to 3 m)
- Incubation cores were sealed and solute and gas samples collected; Changes over time (days) in nutrients and other parameters measured
- Cores were incubated at in situ temperature
- Depending on depth of site, both light and dark exposures were compared

Site and seasonal comparison:

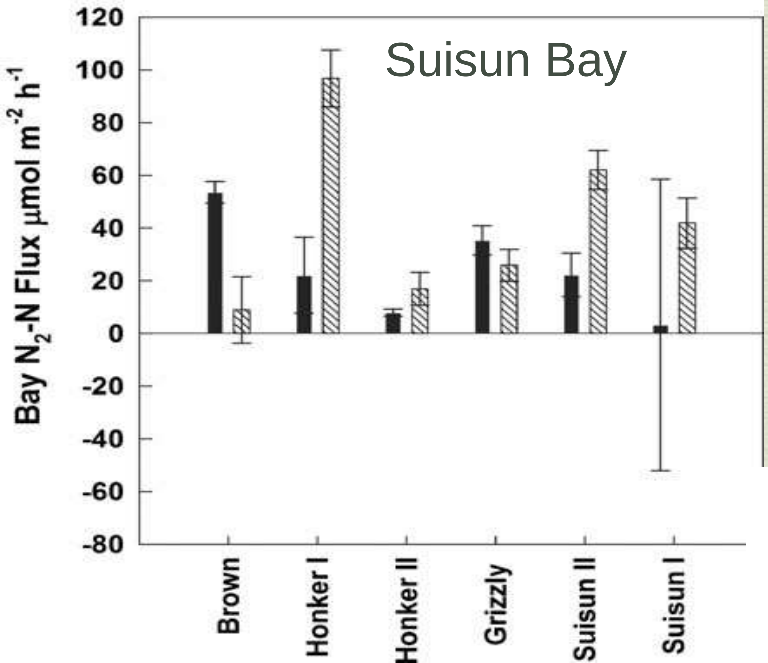
Rates of N_2 flux -denitrification

Rates about 50-100 μM m^{-3} h^{-1}; Moderate rates- on par with many other estuaries (but lower than Chesa Bay)



efflux

influx



efflux

influx

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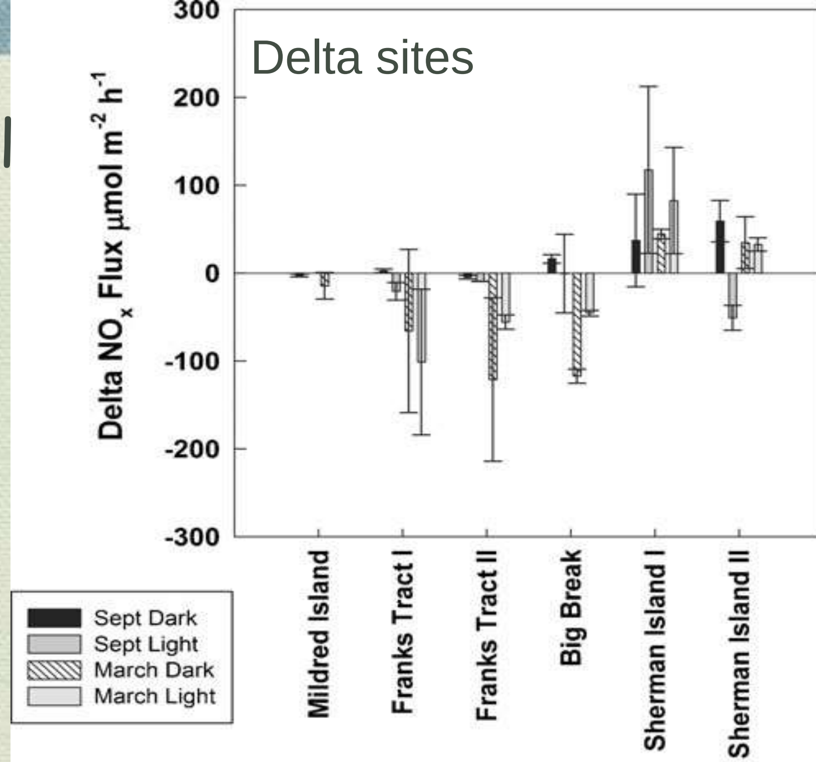
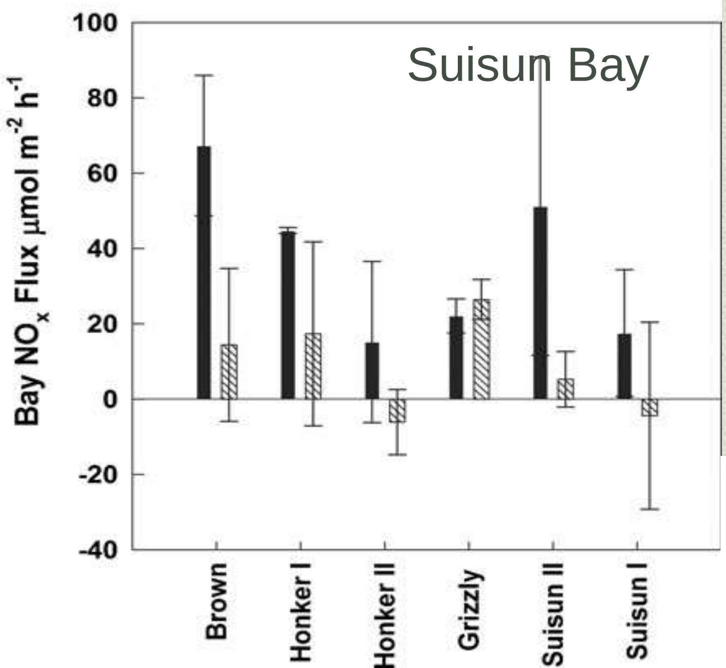
Site and seasonal comparison:

Rates of NOx flux-
Uptake or nitrification



efflux

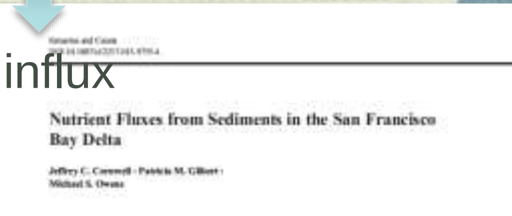
influx



efflux

influx

NOx generally showed consumption in the delta sites (benthic uptake) but efflux in the bay sites



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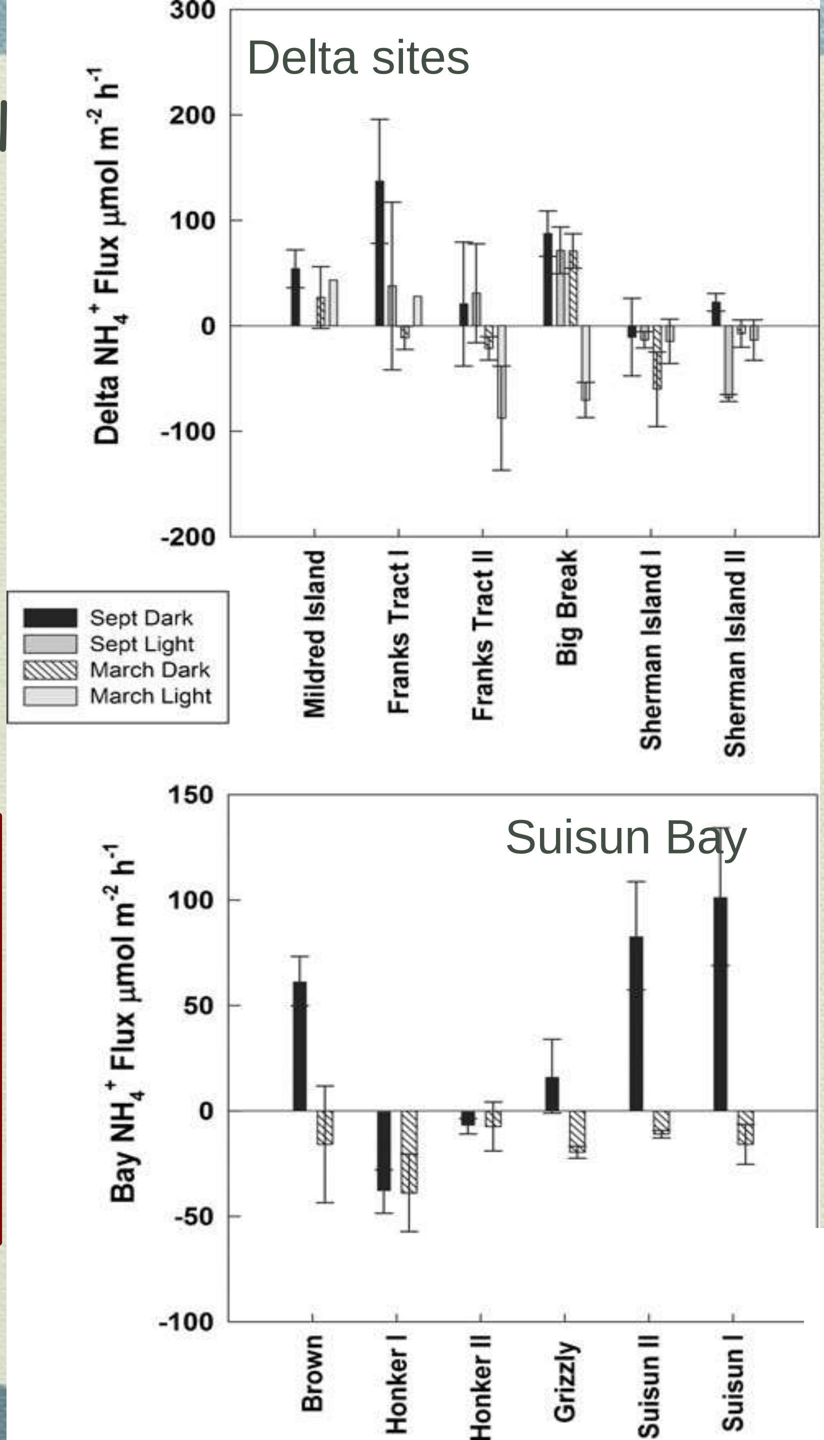
Site and seasonal comparison

Rates of NH_4 fluxes

NH$_4$ generally showed consumption in the bay sites (except in Suisun in Sept) but efflux in the delta sites—*Opposite of NOx fluxes*



efflux

influx

efflux

influx

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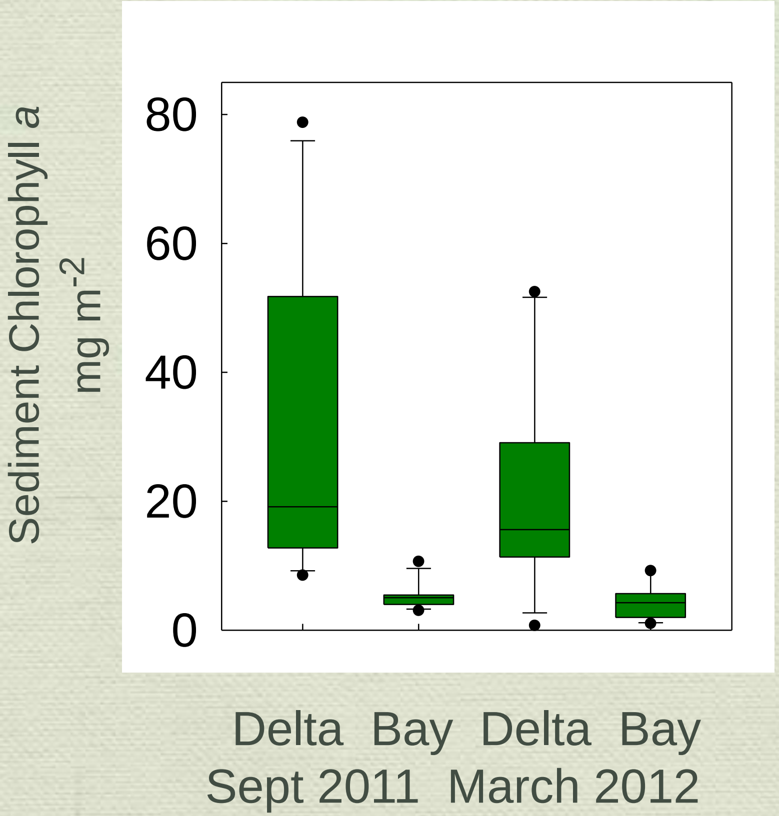
Benthic Chlorophyll

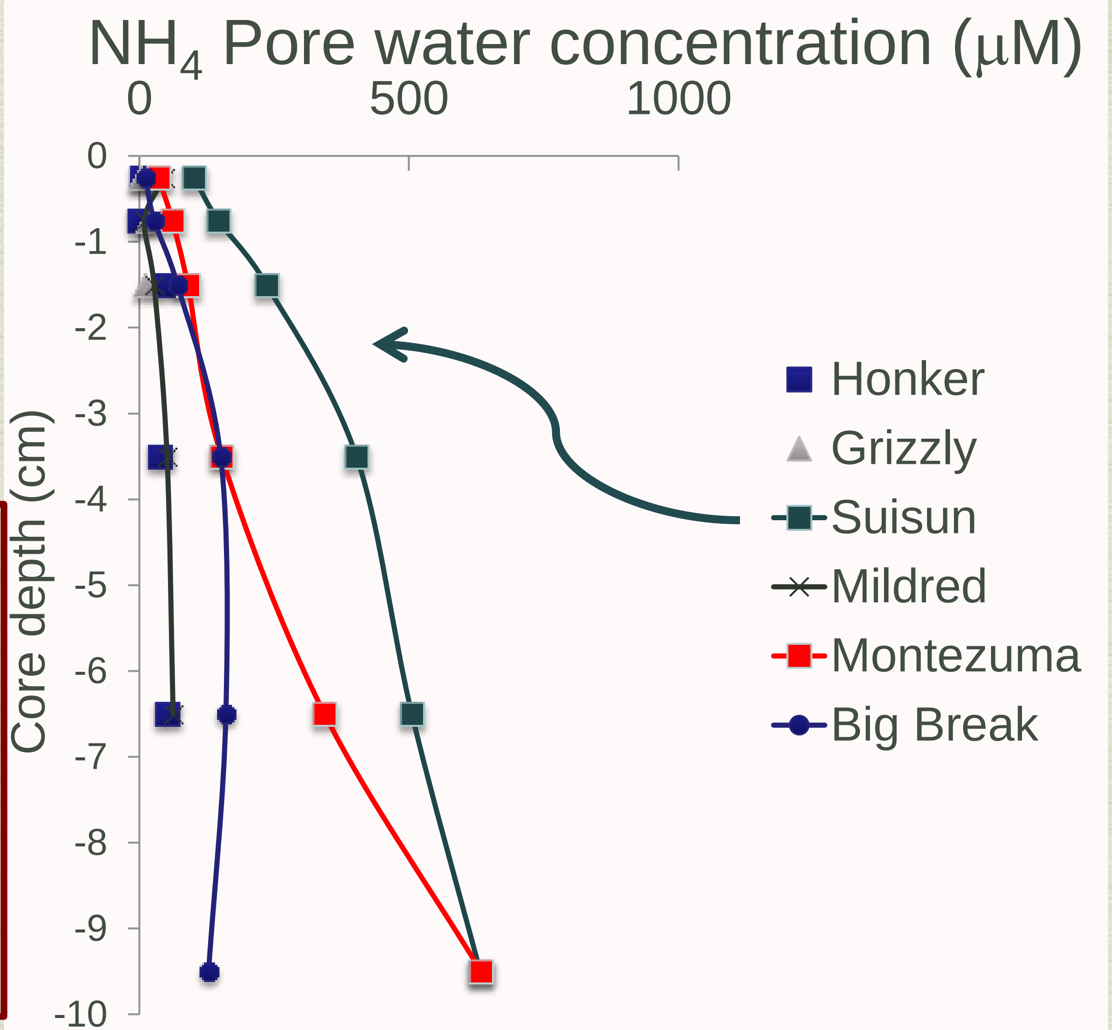


Benthic chlorophyll higher in the Delta sites and lower in the Bay sites

Site and seasonal comparison

NH_4 in Pore water

The highest NH_4 in pore water was found in Suisun Bay and Montezuma Slough. Low pore water concentrations in Honker, Grizzly Bays

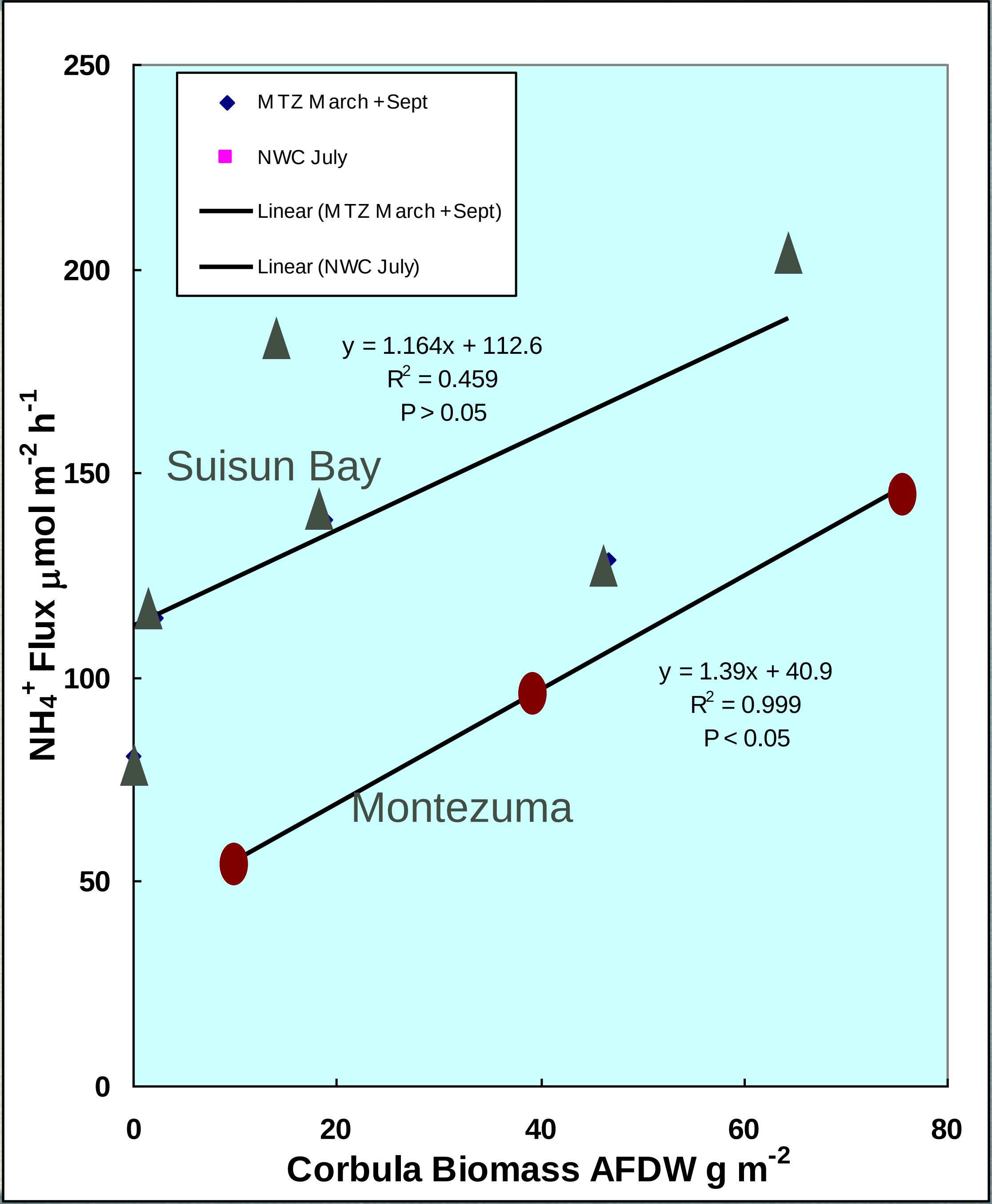


Site and seasonal comparison

NH_4 fluxes

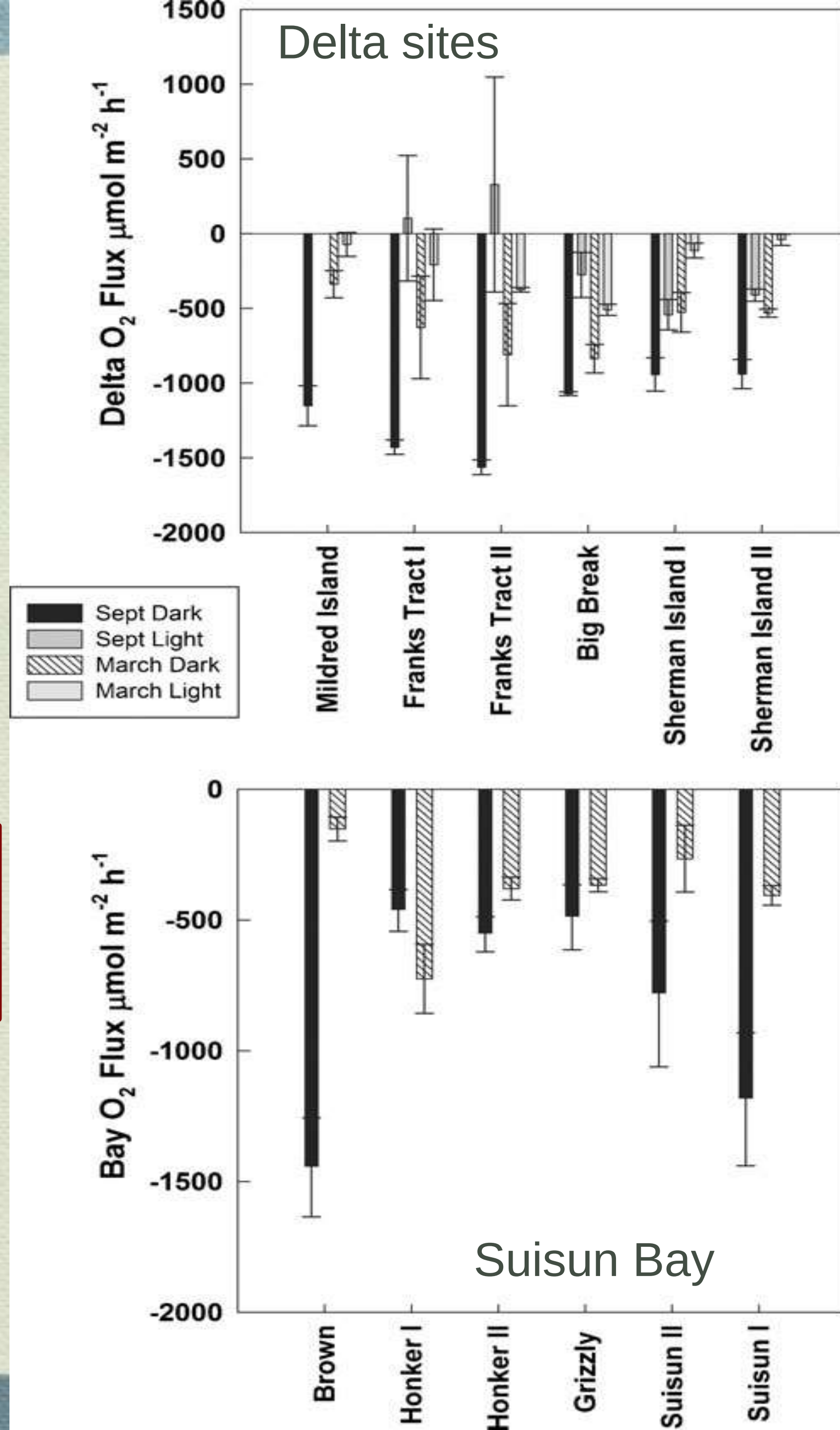
Role of *Corbula*

Correlations between clam biomass and NH_4^+ flux were observed from two sites, but based on literature values, the NH_4^+ flux is low for the observed clam biomass.



Site and seasonal comparison

Rates of O_2 fluxes



efflux

influx

influx

O_2 generally showed consumption at all sites (respiration)

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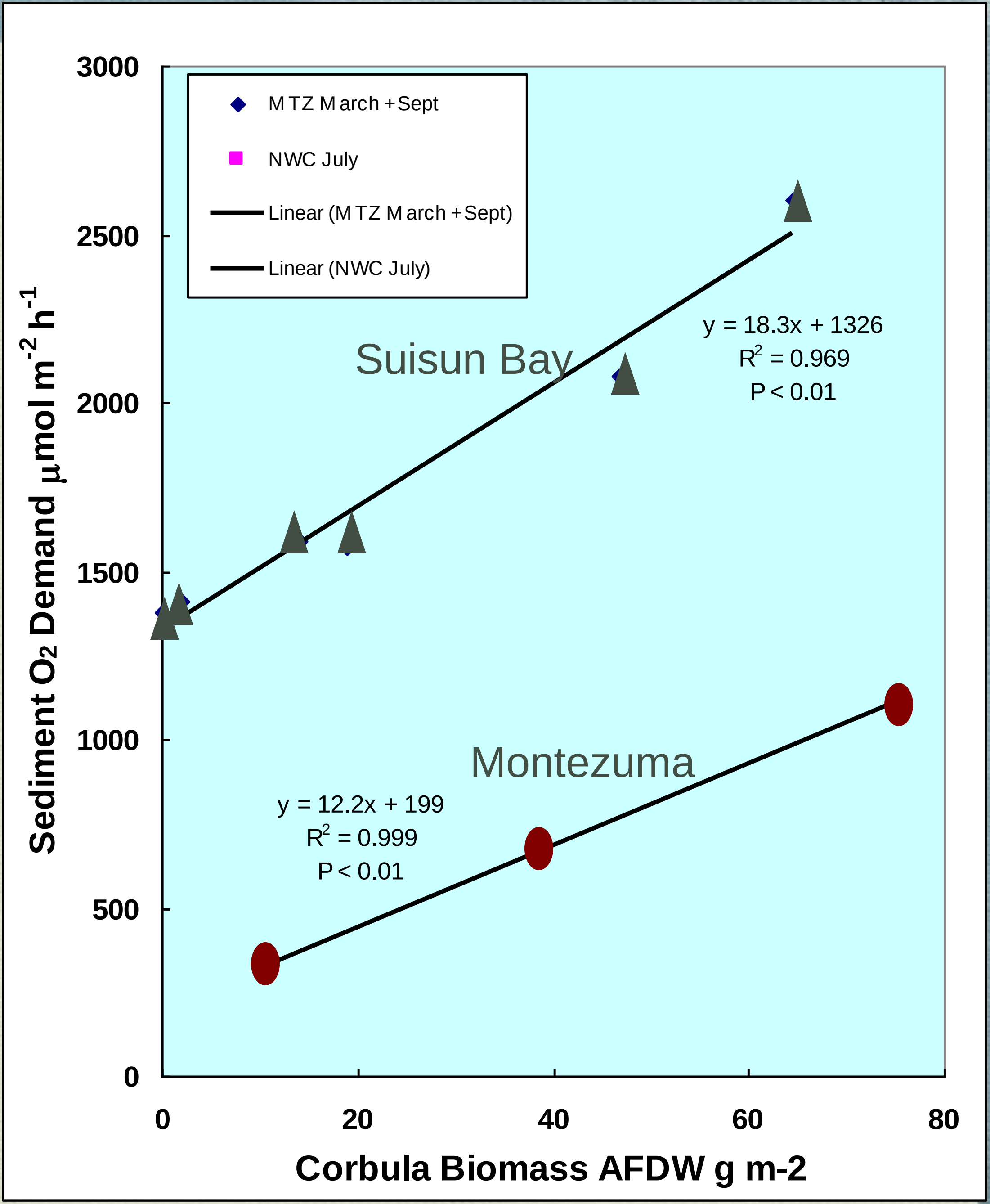
Site and seasonal comparison

Rates of O_2 fluxes

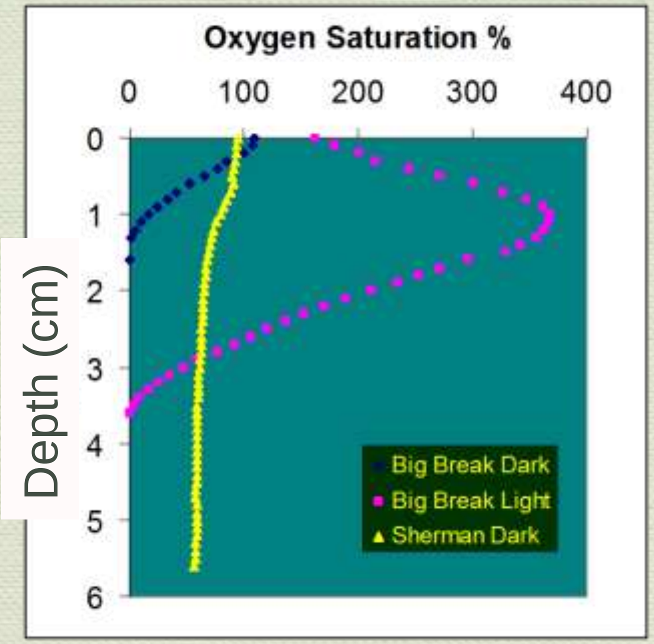
Role of *Corbula*

O_2 uptake linearly correlated to *Corbula* biomass at both sites.



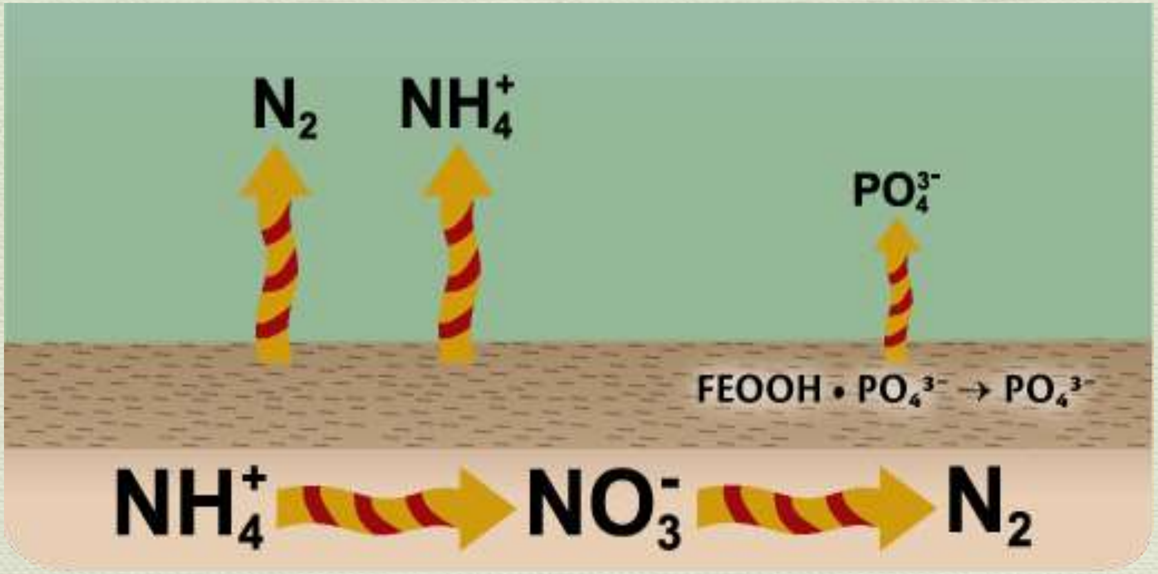
Role of bioirrigation

O_2 microelectrode profiling generally showed 1-2 cm of O_2 penetration, except in cores from Sherman Island, which maintained O_2 to > 5 cm because of extensive worm activity.



Sherman

Salinity and pH changes affect biogeochemistry and nutrient recycling. Nutrients may be driven out of the sediment

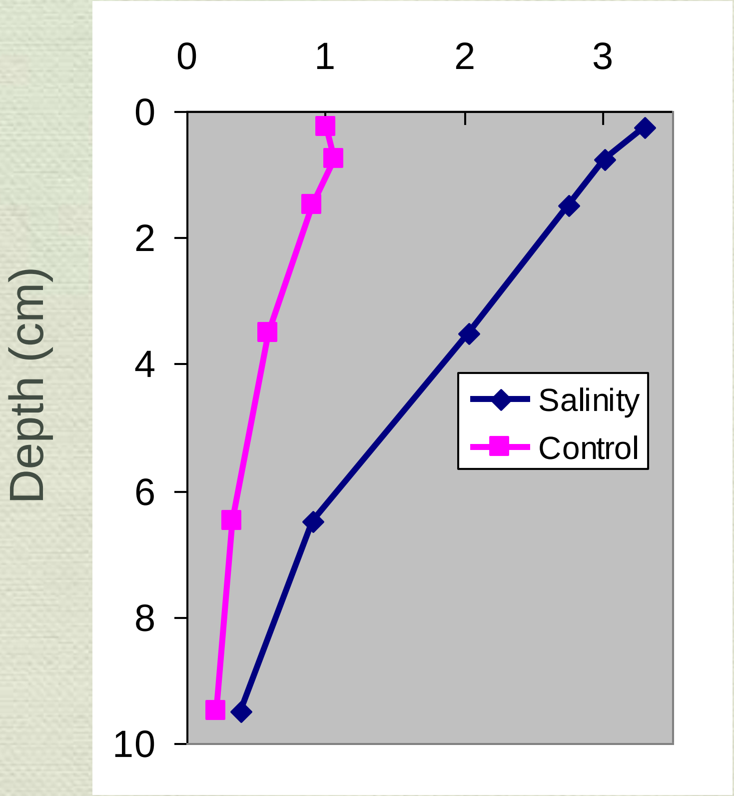


Short-Term Salinity Addition Experiments

- Cores had more saline bay waters added to the overlying water for ~5 days to examine changes in N and P fluxes

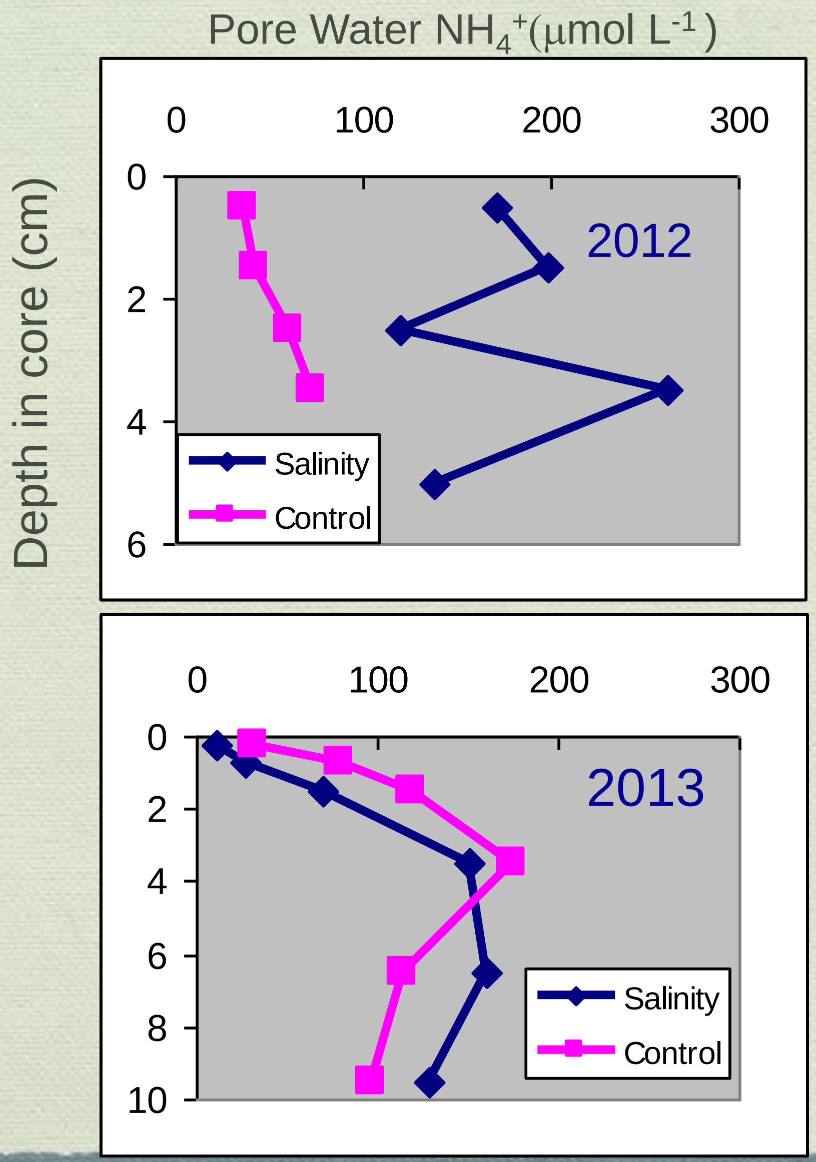
- In March 2012 we increased salinity from 0.2 to 2.1, in March 2013 from 1.0 to 3.3.

March 2012
Big Break
Pore Water Salinity

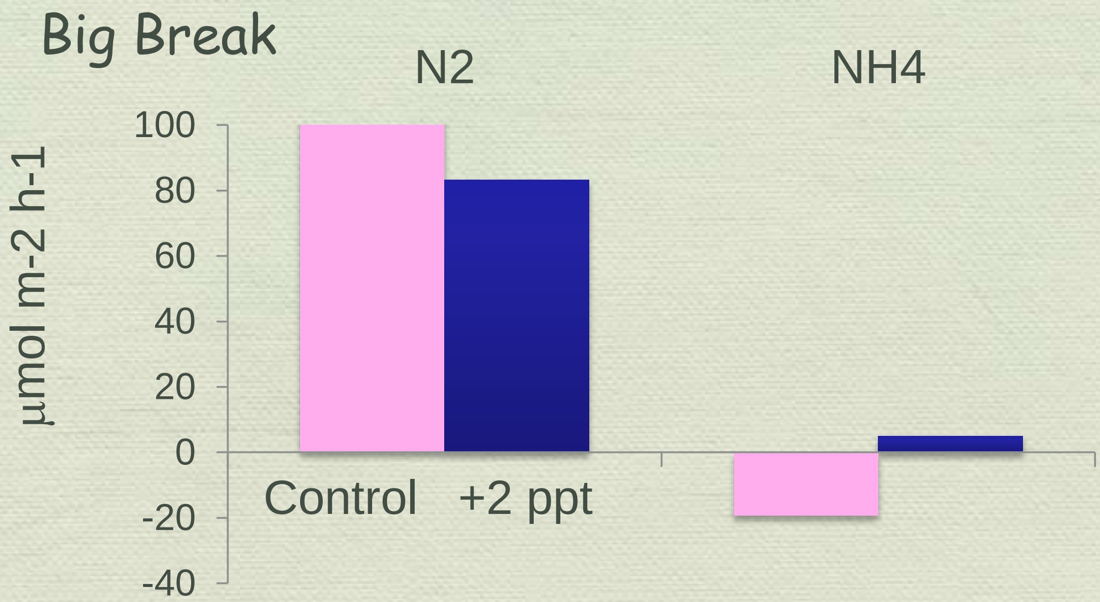


Short-Term Salinity Addition Experiments

- Some salinity-driven accumulation of pore water NH_4^+ in 2012 from NH_4^+ desorption; less in 2013 but starting at higher salinity



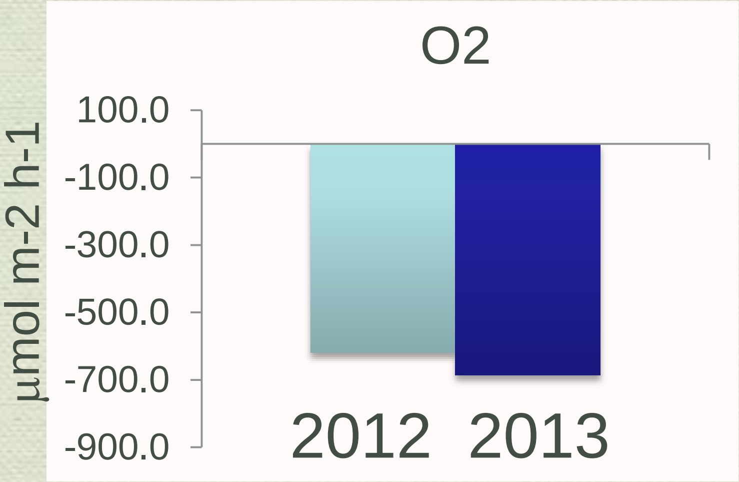
Short-Term Salinity Addition Experiments

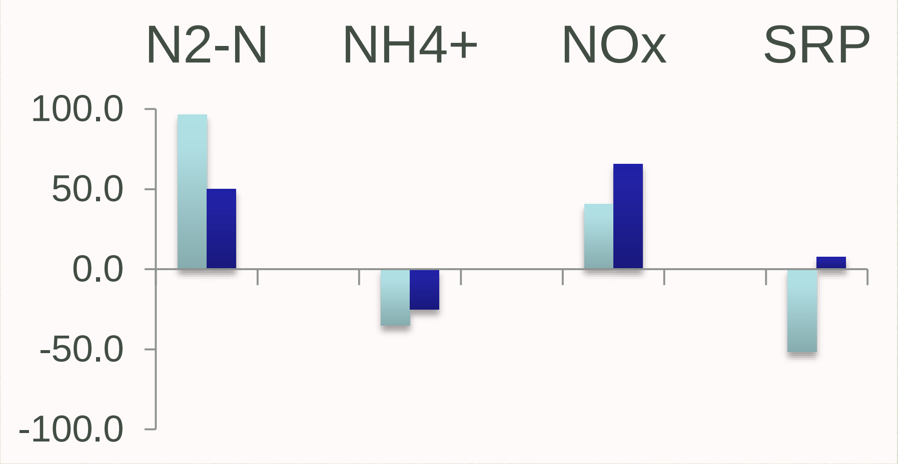


Salinity addition experiments in 2013 resulted in relatively small changes in denitrification but a net change in NH4 consumption/efflux

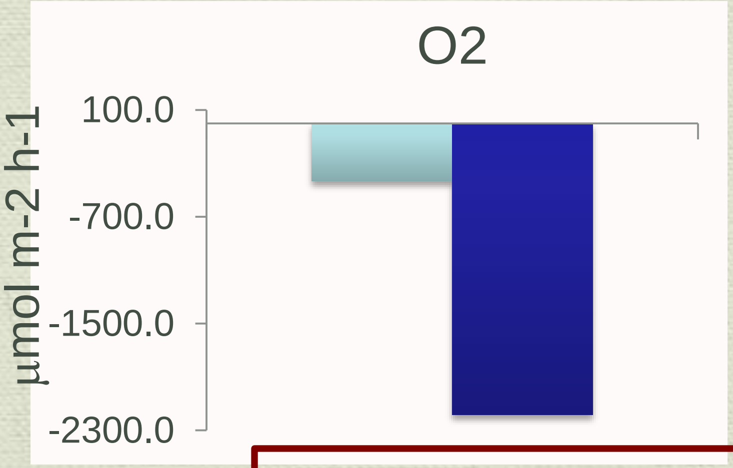
Comparing Fluxes in March 2012 and 2013

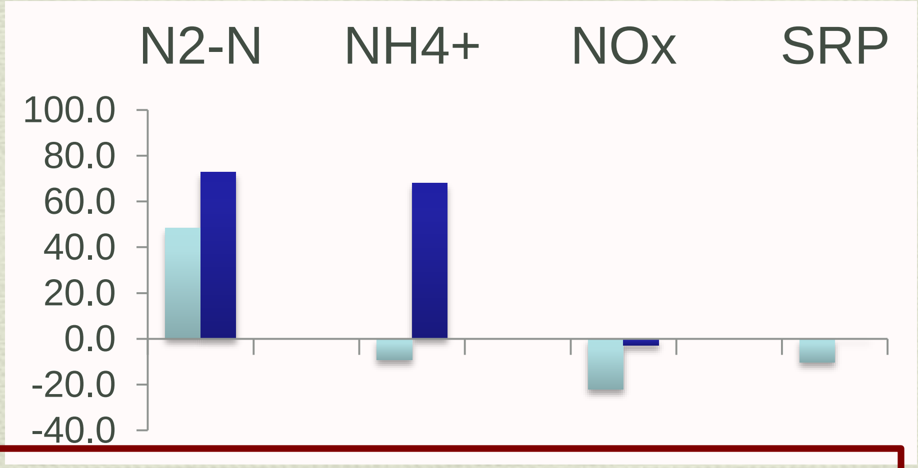
Sherman Island: similar





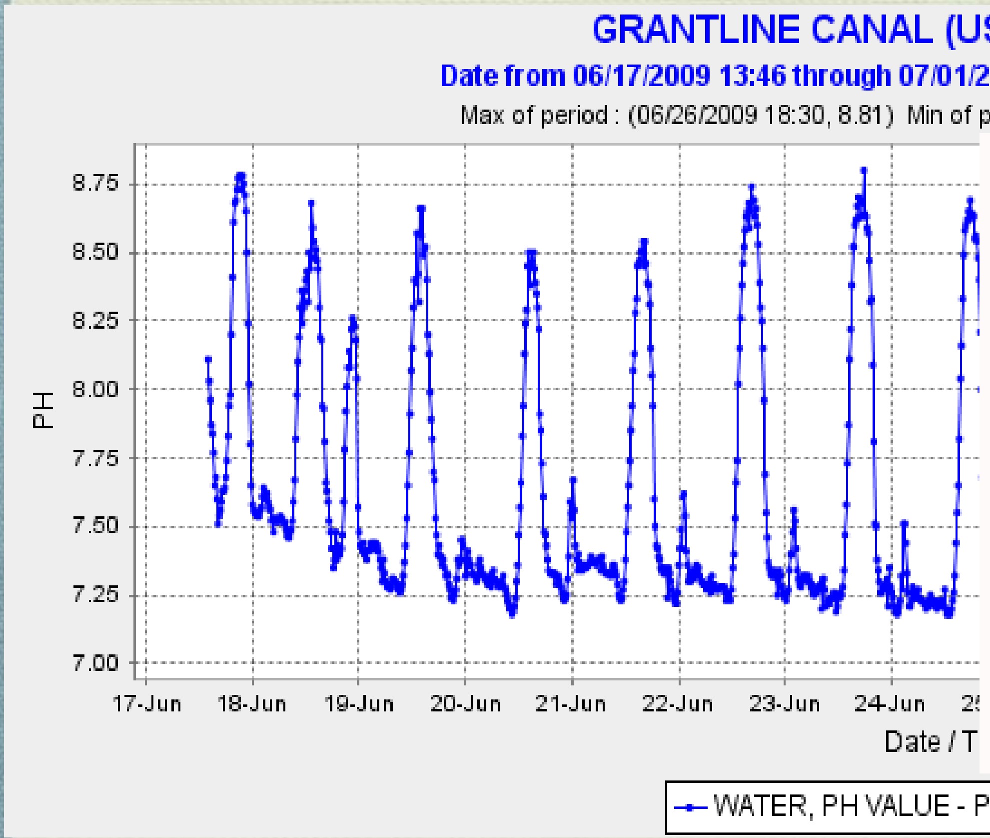
Suisun Bay: O_2 and NH_4 very different

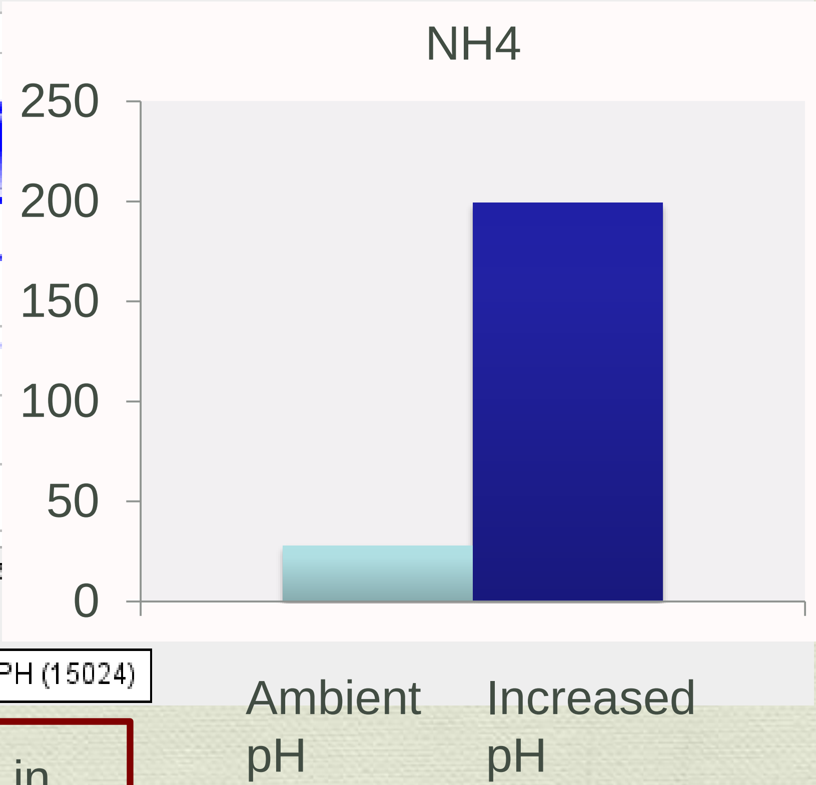




2013 had much higher O2 consumption and NH4 flux

Short-Term pH Manipulation Experiments





Increased pH (from enhanced productivity in macrophyte beds or *Microcystis* blooms) can lead to enhanced flux of NH_4, in turn, helping to sustain production

Sherman Island

Conclusions

- Sediment fluxes in Suisun – Delta environments are dynamic and variable with season and site but are of moderate magnitude compared to other highly productive estuaries

- Environmental controls of the rates of O_2, N_2, and nutrient exchange include overlying nutrient concentrations and productivity, benthic chlorophyll and productivity, biomass of invasive *Corbula*, and bioirrigation by benthos, temperature, salinity and pH

- Predictive models of nutrient dynamics should include sediment processes!

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cornwell@umces.edu

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