Designing Constructed Wetlands to Reduce Mosquito Production: Alternative Emergent Macrophytes

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Functions of emergent macrophytes in wetlands

- Reduce flow and mixing to enhance sedimentation
- Adsorption of particulates
- Reduce variation in environmental factors
- Provide physical structure for microbes and other biota
- Uptake and storage of nutrients
- Oxygenation of sediments
- Enhance denitrification

http://www.victoria-adventure.org/aquatic_plants/gallery_m-z.html

Large macrophytes used in constructed treatment wetlands…

Schoenoplectus californicus
(California bulrush)

Schoenoplectus acutus
(hardstem bulrush)

Phragmites australis
(common reed)

***Typha* spp.** (cattail)

Problems associated with large emergent macrophytes in constructed wetlands

- Increased mosquito production
- Reduced effectiveness of abatement measures
- High costs of management
- Reduced wetland performance for improving water quality

Can we find an alternative smaller macrophyte with the following characteristics?

S. californicus

S. maritimus

- survives in a wide range of nitrogen concentrations
- reduces harborage for mosquitoes: dead biomass sinks quickly or decomposes rapidly
- enhances the efficacy of biorational mosquito control agents
- less costly to manage
- provides comparable or better nutrient reduction
- provides ancillary benefits (e.g., wildlife forage)

Effect of NH_4-N gradient on alkali bulrush

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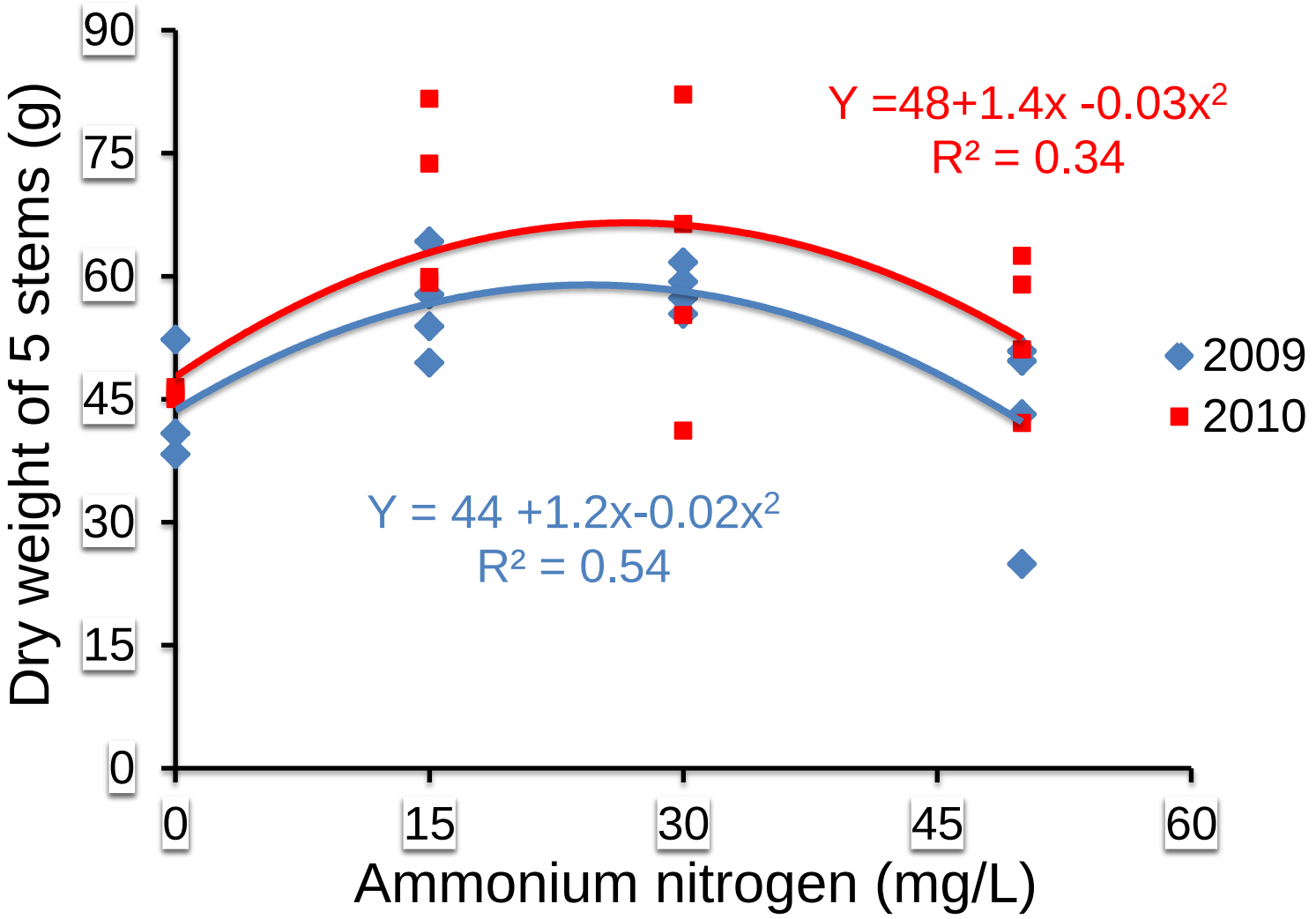
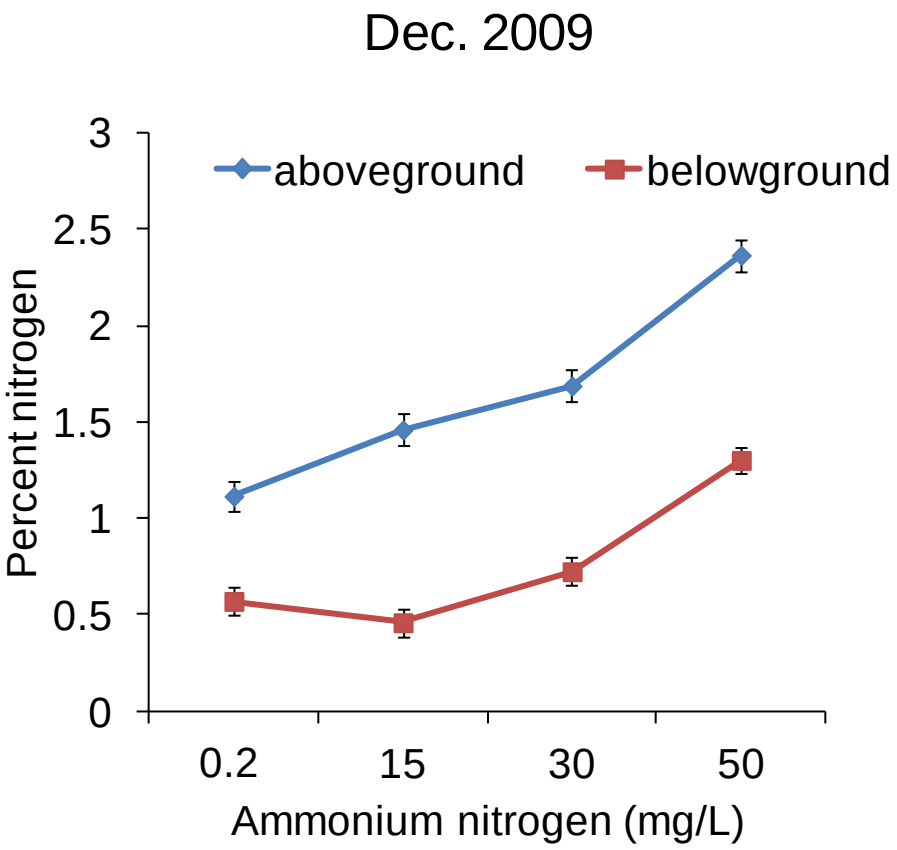
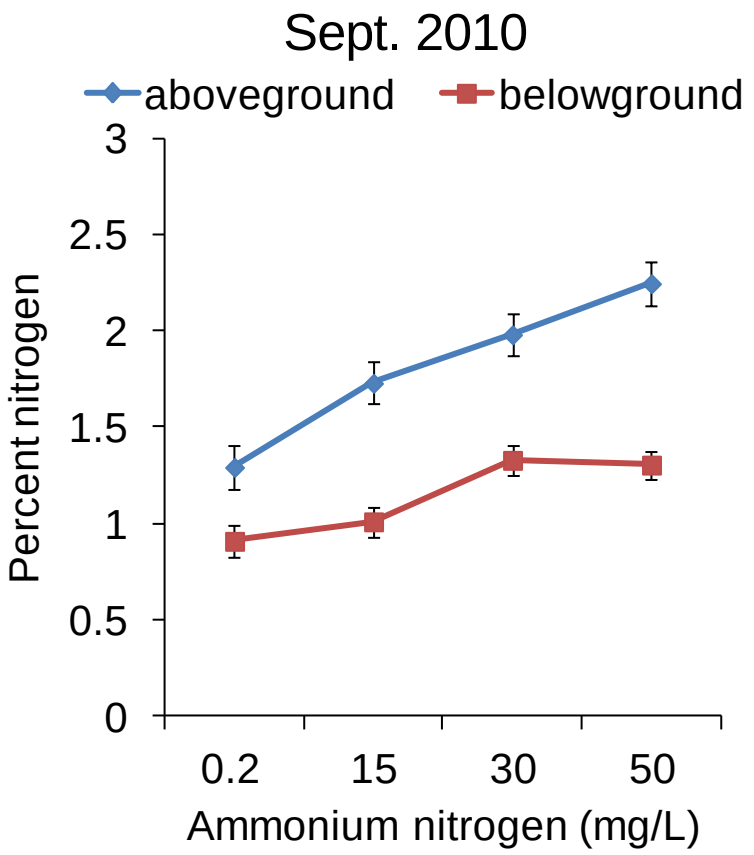
Effect of NH_4-N gradient on total dry weight biomass: *S. maritimus*

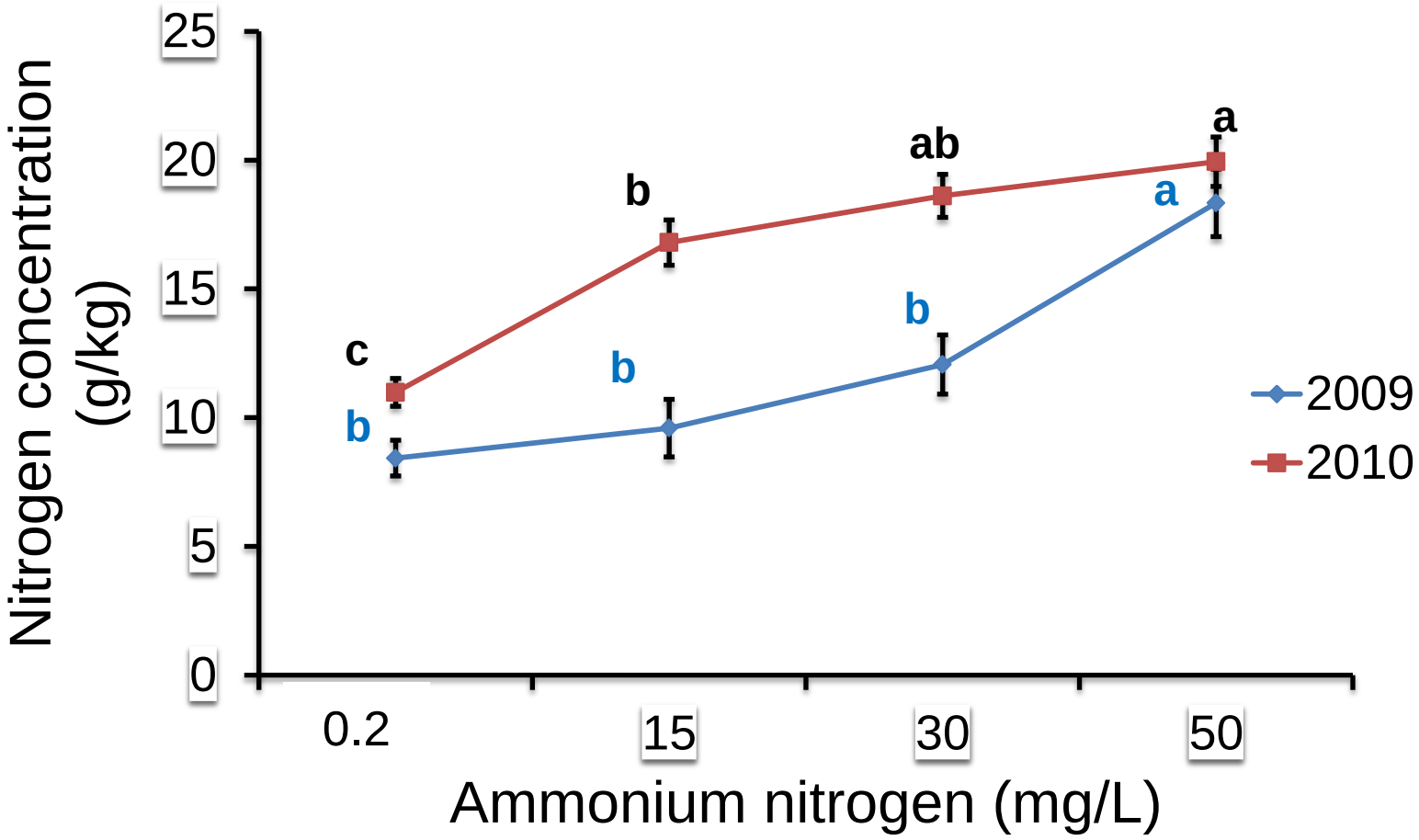


Percent Nitrogen: *S. maritimus*

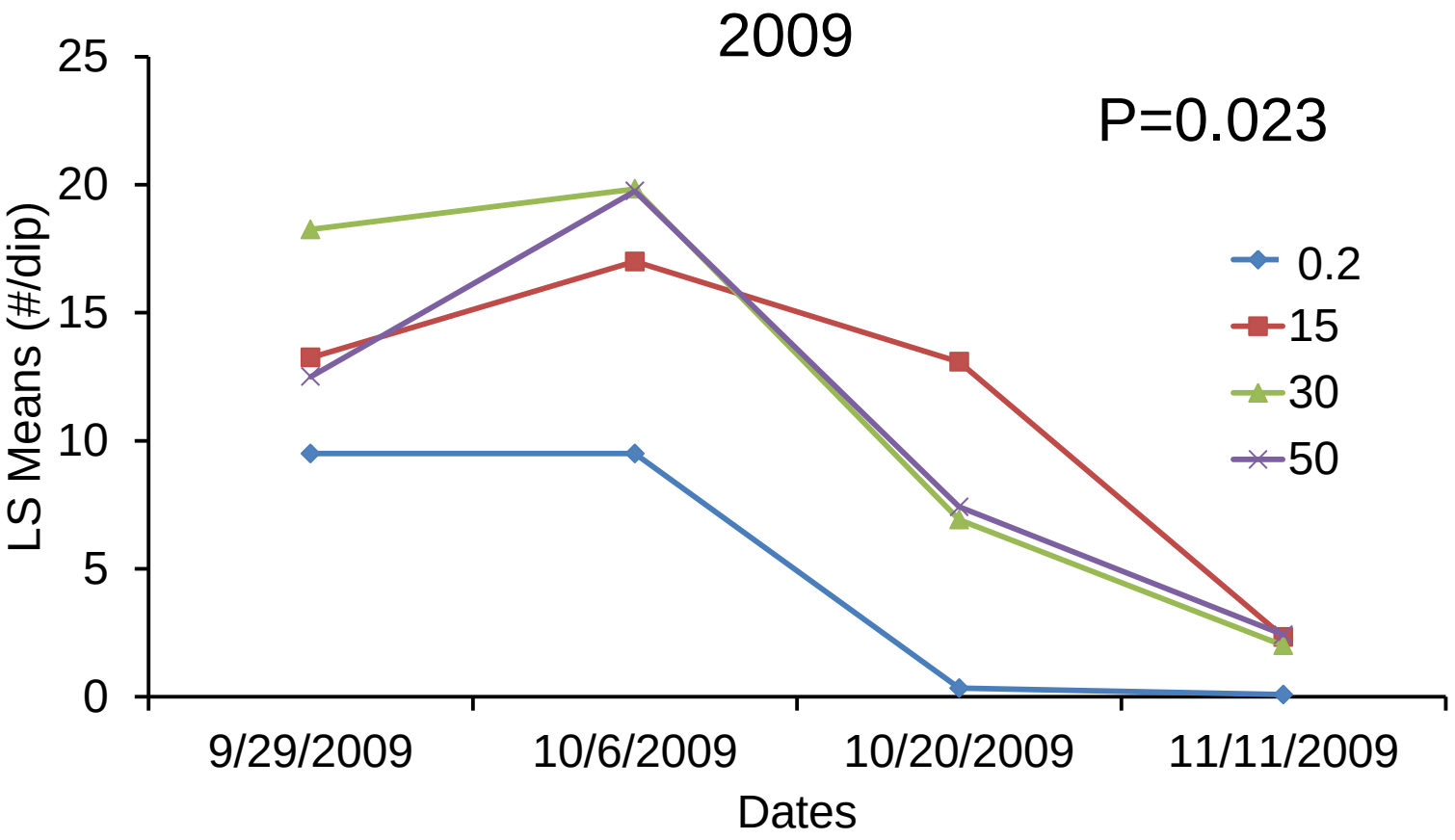




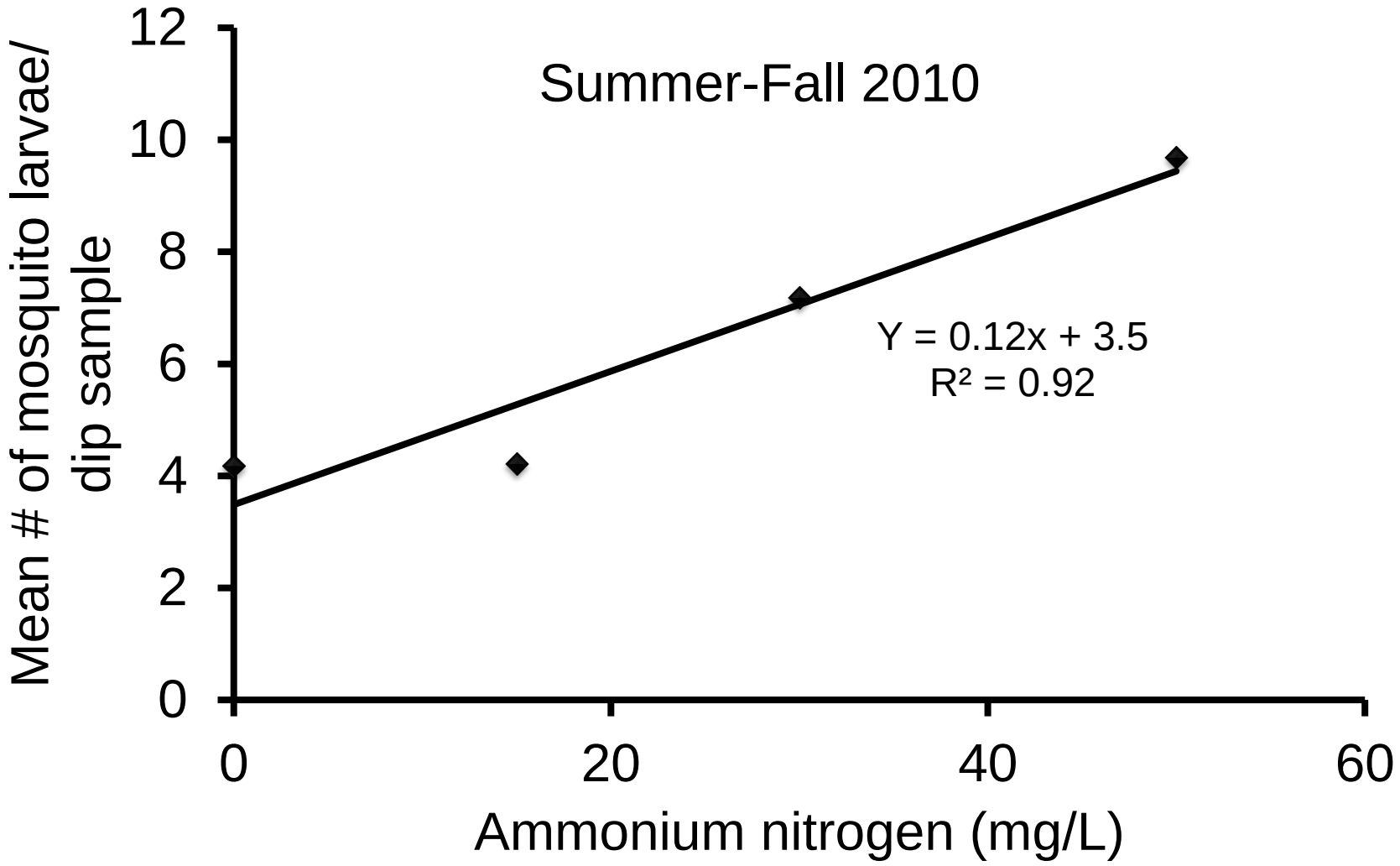
Effect of NH_4-N on Nitrogen Concentration: *S. maritimus*



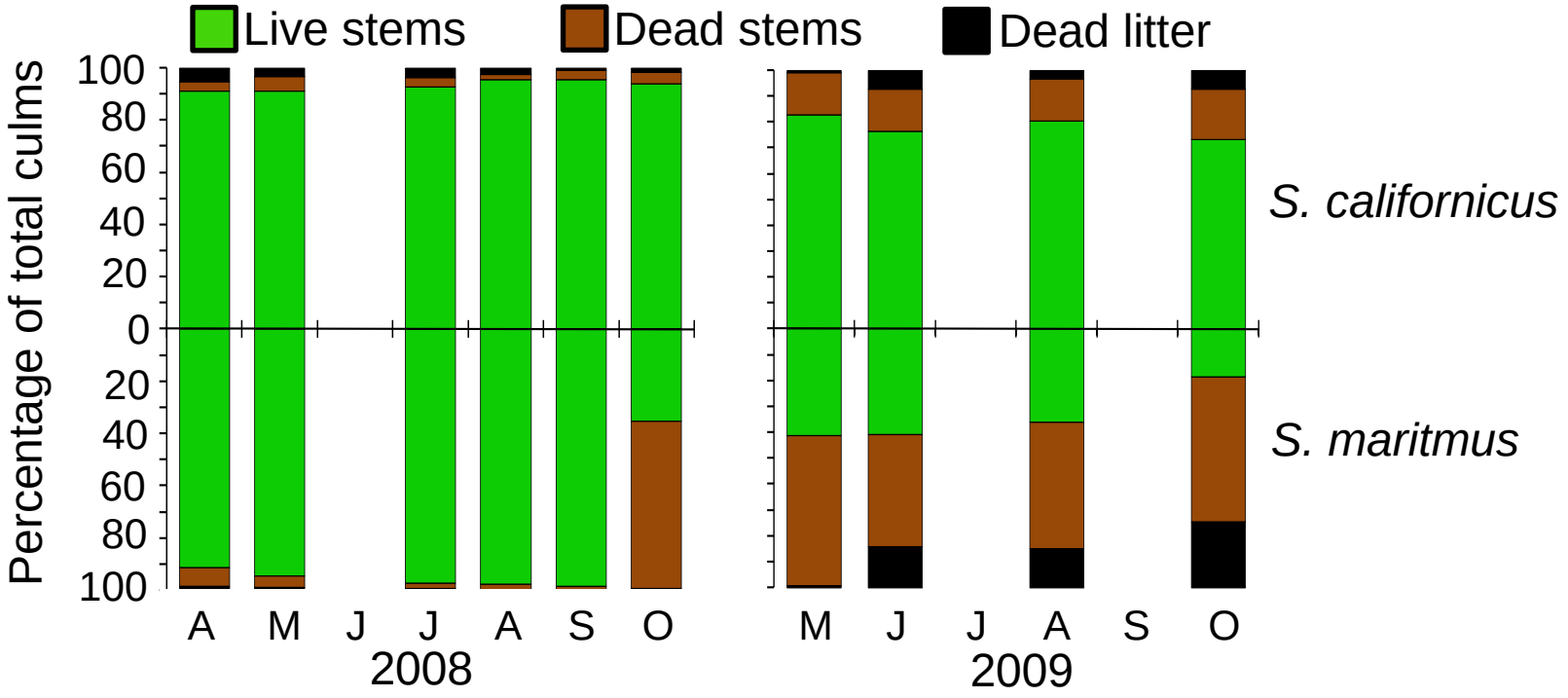
Immature mosquitoes enhanced by enrichment



Direct effect of NH_4-N gradient on mosquitoes



Seasonal phenologies of the two bulrushes differ…



Seasonal phenology of *S. maritimus*

December ⇨ mid-February ⇨ mid-March ⇨ May

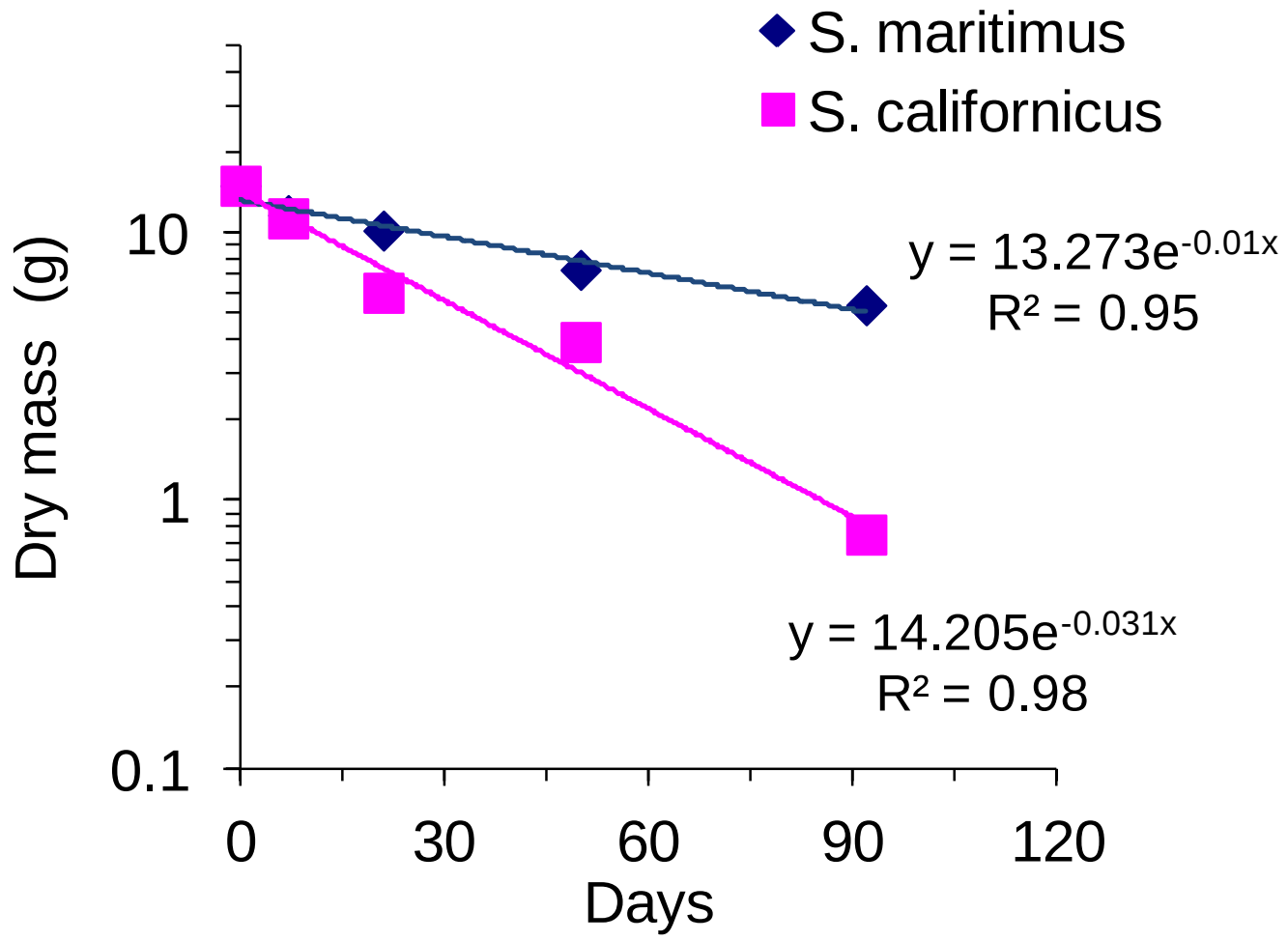
Most inundated dead *S. maritimus* culms sank within 30 days.

Most inundated dead *S. californicus* culms were still floating after 90 days.

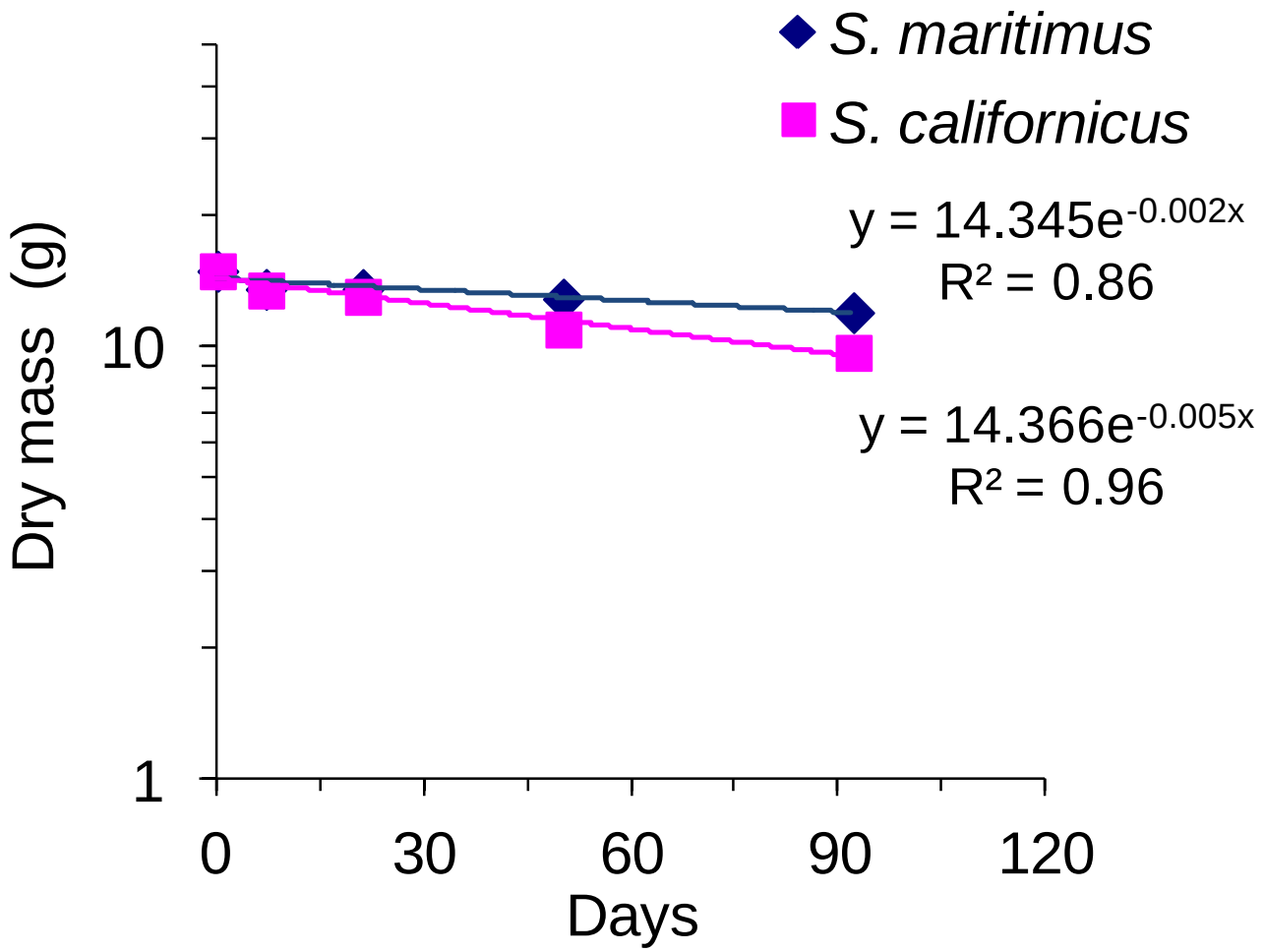
Seasonal phenology of *S. maritimus*

December ⇨ mid-February ⇨ mid-March ⇨ May

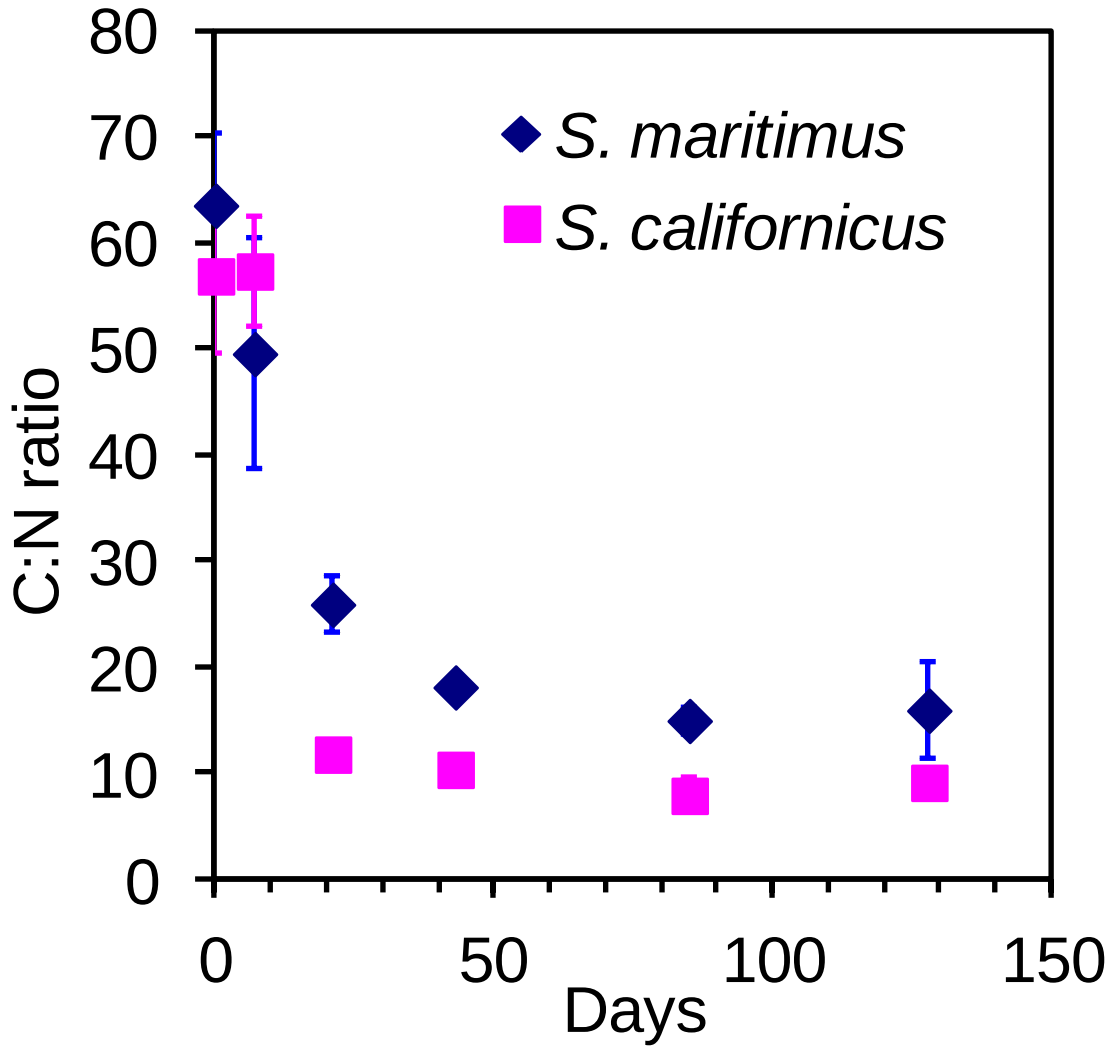
Change in dry mass during decomposition in the VSD wetlands, Indio CA: 30 April – 31 July



Change in dry mass during decomposition in the VSD wetlands, Indio CA: 22 Dec. – 24 March

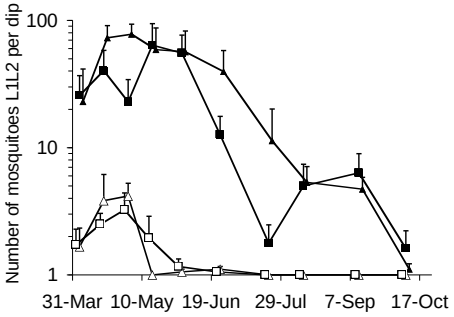


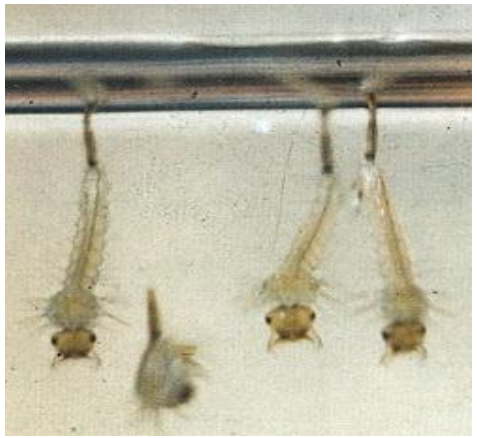
Change in C:N during decomposition in the VSD wetlands, Indio CA



Fewer late-instar *Culex* larvae in *S. maritimus*…

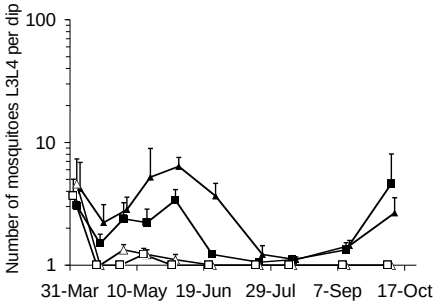
▲ CA -sp ■ Mar -sp △ CA +sp □ Mar +sp





More predatory insects in *S. maritimus*…

▲ CA -sp ■ Mar -sp △ CA +sp □ Mar +sp



Zygoptera

Number of zygopterans per dip + 1

100
10
1

31-Mar 10-May 19-Jun 29-Jul 7-Sep 17-Oct

Conclusions

- *S. maritimus* may be a viable replacement for *S. californicus* and other large emergent macrophytes in some constructed treatment wetlands.
- survives in a wide range of nitrogen concentrations.
- reduces harborage for mosquitoes: dead biomass sinks quickly but does not decompose as rapidly as *S. californicus.*
- enhances the efficacy of biorational mosquito control agents?
- less costly to manage? Easier to remove with hand tools!
- provides comparable nutrient uptake per unit mass but smaller overall mass/plant.
- provides ancillary benefits: wildlife forages on achenes and stems.