# Extreme Climate Events and the Recurrent Sudden Dieback and Recovery of Salt Marshes in the Rapidly Subsiding Mississippi River Delta, Louisiana

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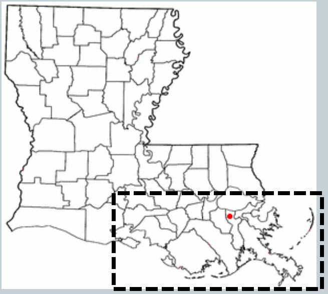
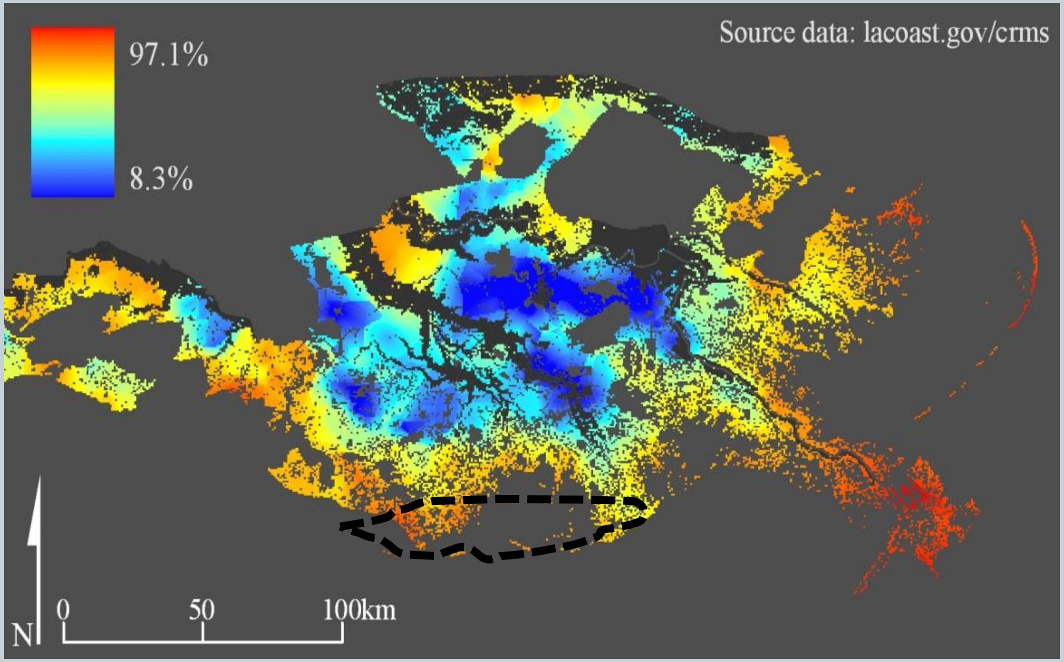
BATON ROUGE

# Salt marshes in the Mississippi Delta in coastal Louisiana, rsl is around 1 cm per year






Map from Andrew Tweel, LSU

# “Non-acute” salt marsh dieback


Mendelssohn and McKee. 1988. *Spartina alterniflora* die-back in Louisiana: Time-course investigation of soil waterlogging effects. Journal of Ecology 76: 509-521

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# Acute saltmarsh dieback

- Dieback occurs quickly, from one growing season to next
- Full recovery frequently occurs
- Occurred in Gulf and Atlantic Coast marshes in 2000s, drought primary driver

Alber, et al. 2008. Salt marsh dieback; An overview of recent events in the US. Estuarine, Coastal and Shelf Science, 80: 1-11.

# Acute salt marsh dieback

2000

2006

# BACKGROUND

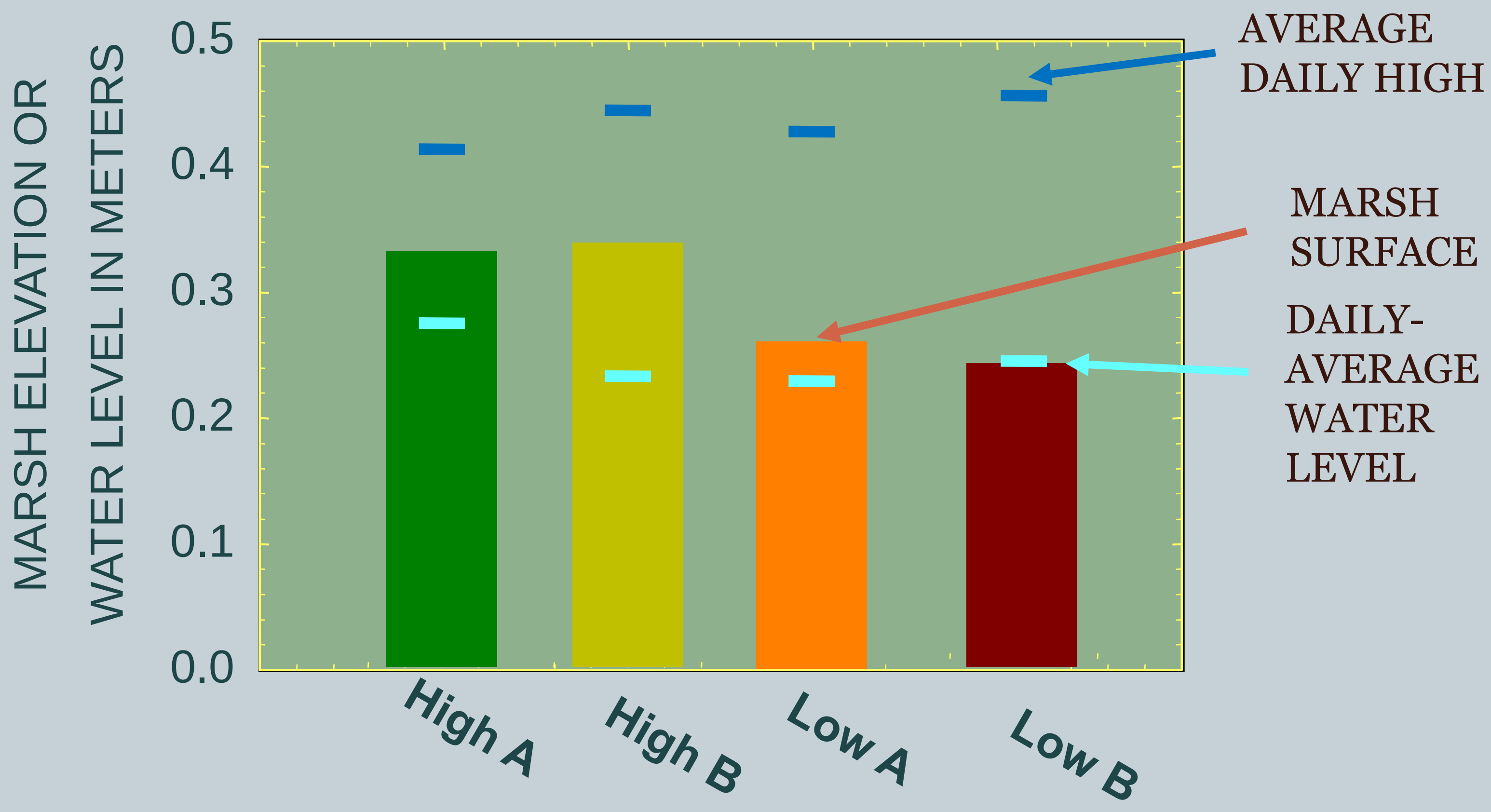
# Timeline coastal Louisiana 1999-2009

CLIMATE

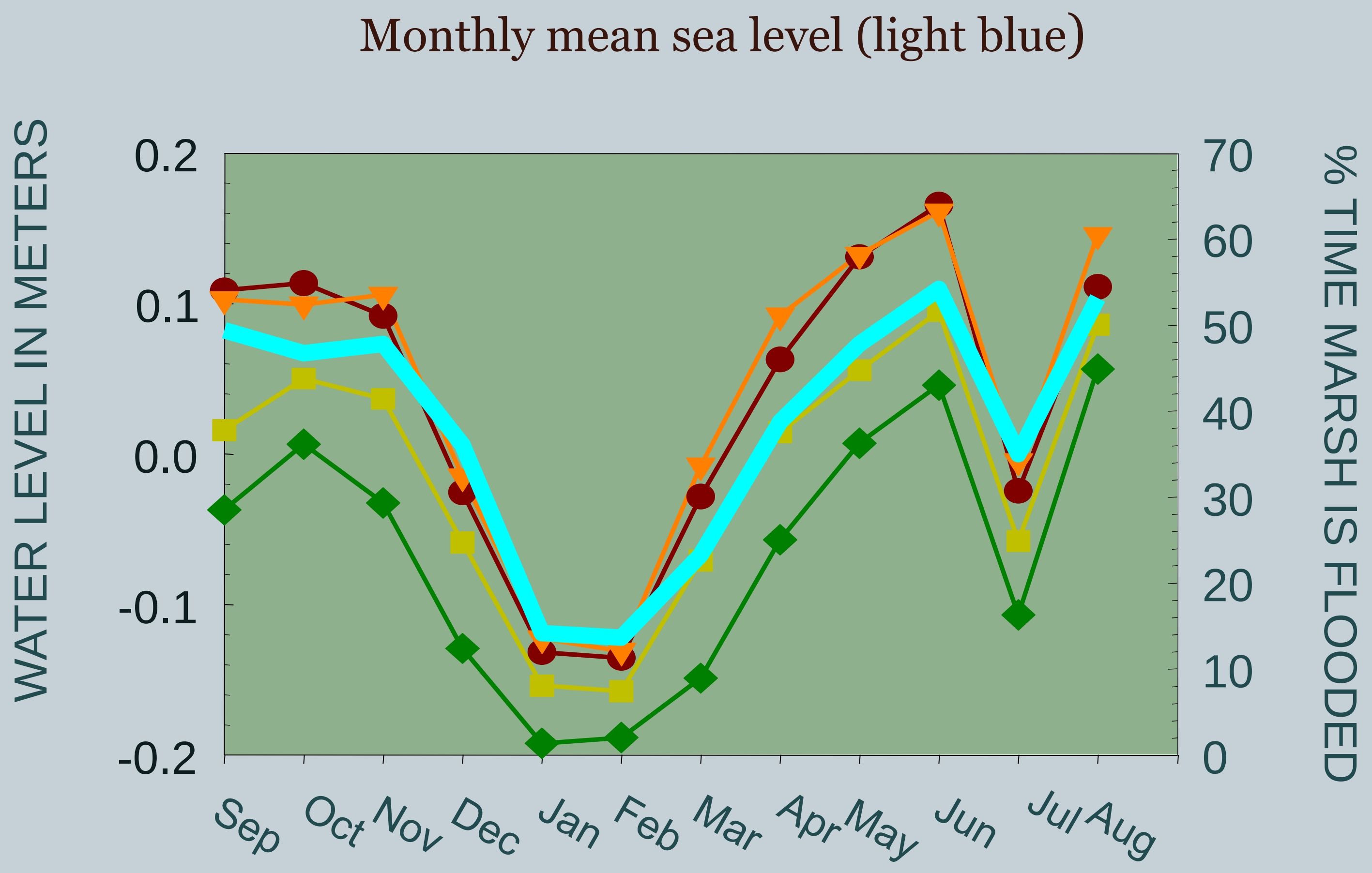
- Exceptional drought (1999-2000, 2006)
- Back to back hurricanes in 2005 and 2008

- SALT MARSH DIEBACK
- 2000 (about 100,000 ha or 25%, widespread)
- 2009 (smaller area, regional distribution)

# Range of marsh elevations with respect to local water levels



# Seasonal marsh flooding, related to Gulf level

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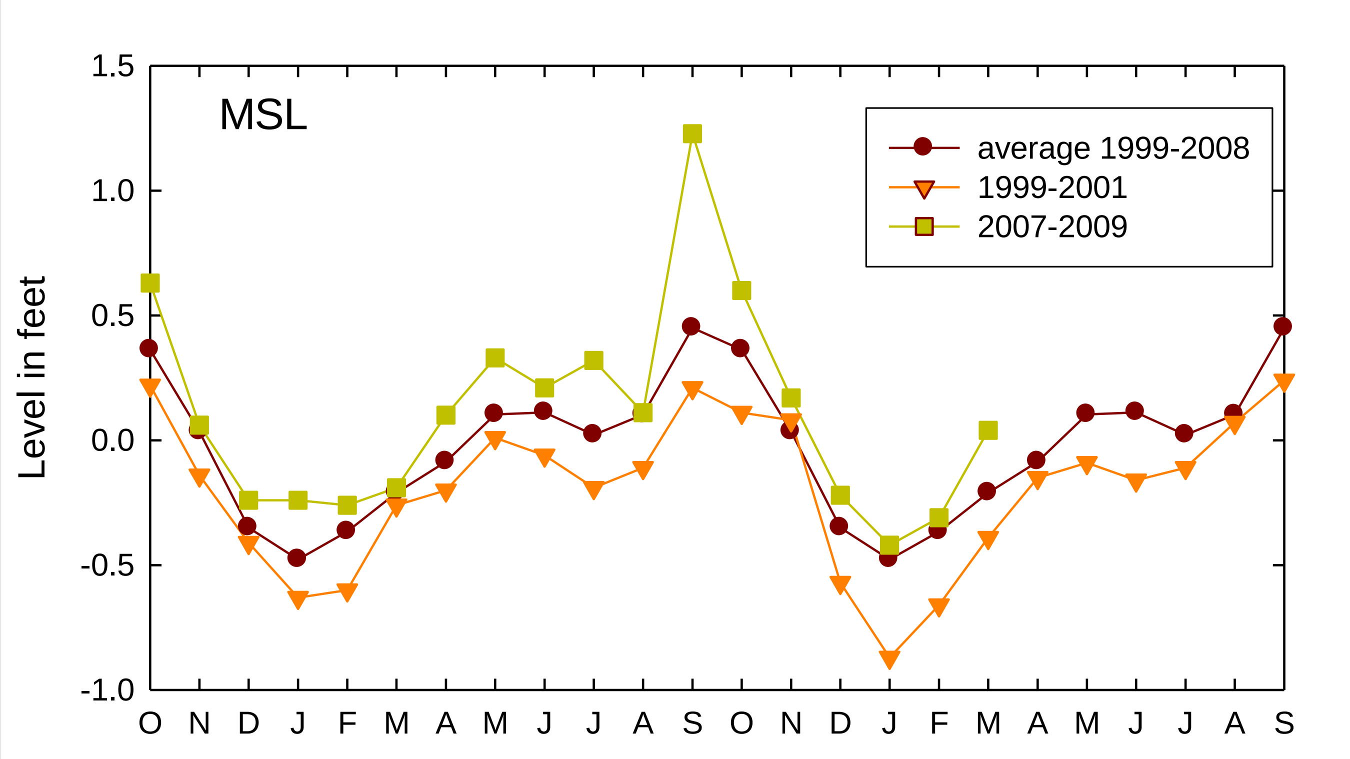
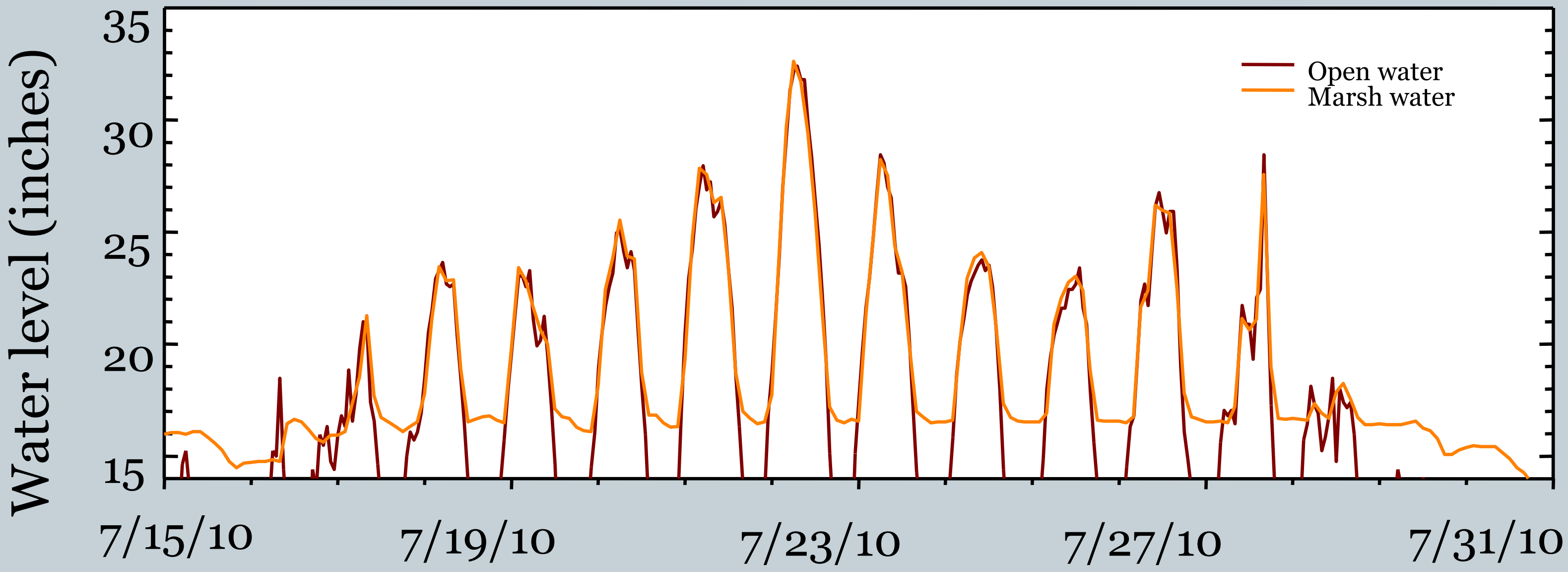
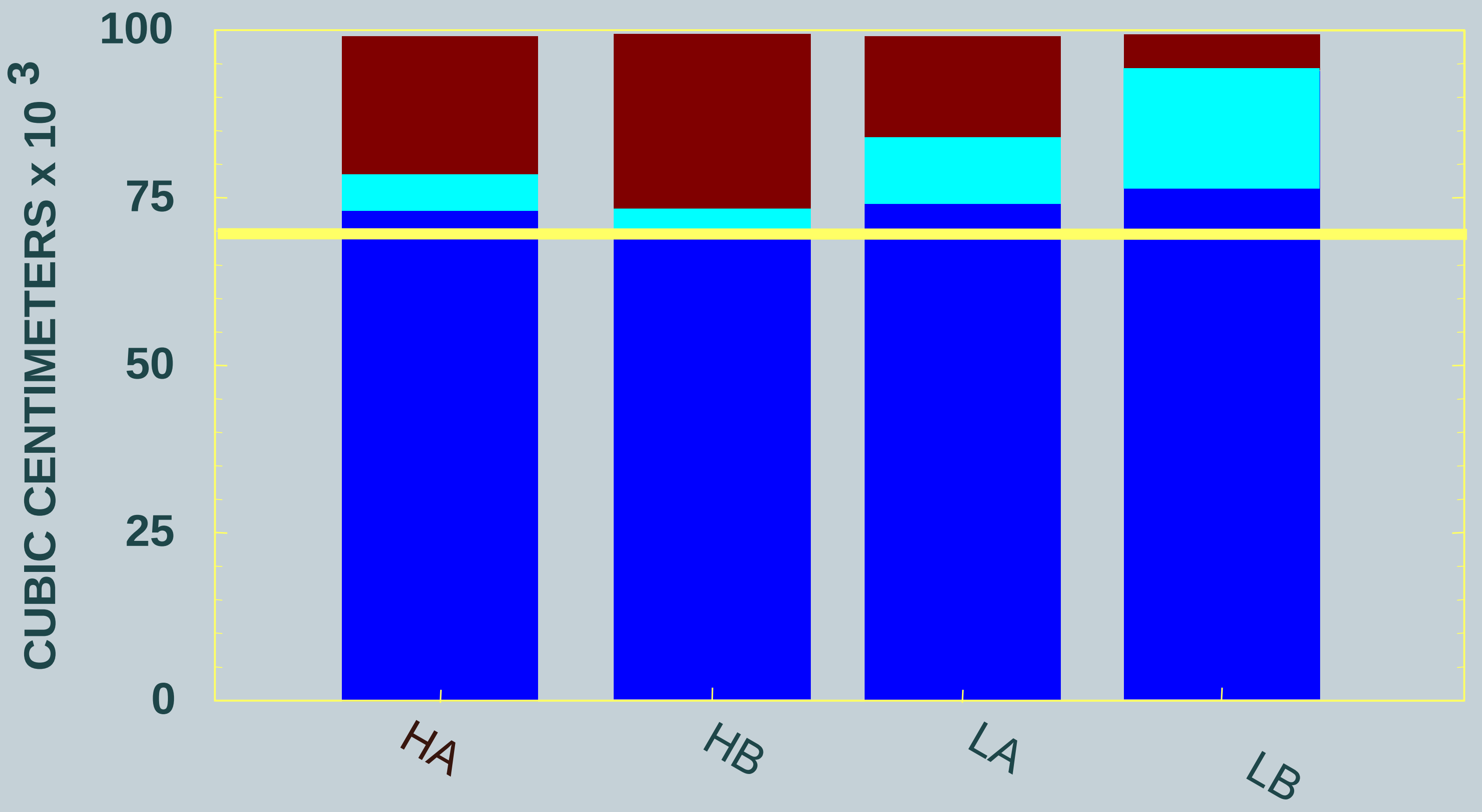
# Gulf levels vary from year to year, with long stretches remaining higher or lower than average



# Microtidal flooding regime, daily flooding alternating with extended periods of drawdown



# Volume of free water greater in low elevation marshes



# 2000 DIEBACK

FIRST NOTICED IN MARCH/APRIL, POSSIBLE THAT DIEBACK OCCURRED AFTER NEW GROWTH FIRST STARTED

DIEBACK LINKED TO DROUGHT

OXIC SOILS -> PH DROP -> RELEASE OF METALS TO TOXIC CONCENTRATIONS

McKee et al. 2004. Acute salt marsh dieback in the Mississippi River deltaic plain: a drought-induced phenomenon? Global Ecology and Biogeography 13(1) p.65-73

# 2000 Dieback (widespread across elevation gradient)

Dieback in interior areas

*Spartina alterniflora* died back, *Juncus roemerianus* survived.

Where both survived *J. roemerianus* taller than *S. alt* where both survived

(photo Karen Mckee, USGS)

# Typical layout of study site

# STUDY DESIGN developed to assess field conditions post-2000 dieback

- Locate paired interior dieback and surviving marshes (N=4)
  replicate high and low marshes

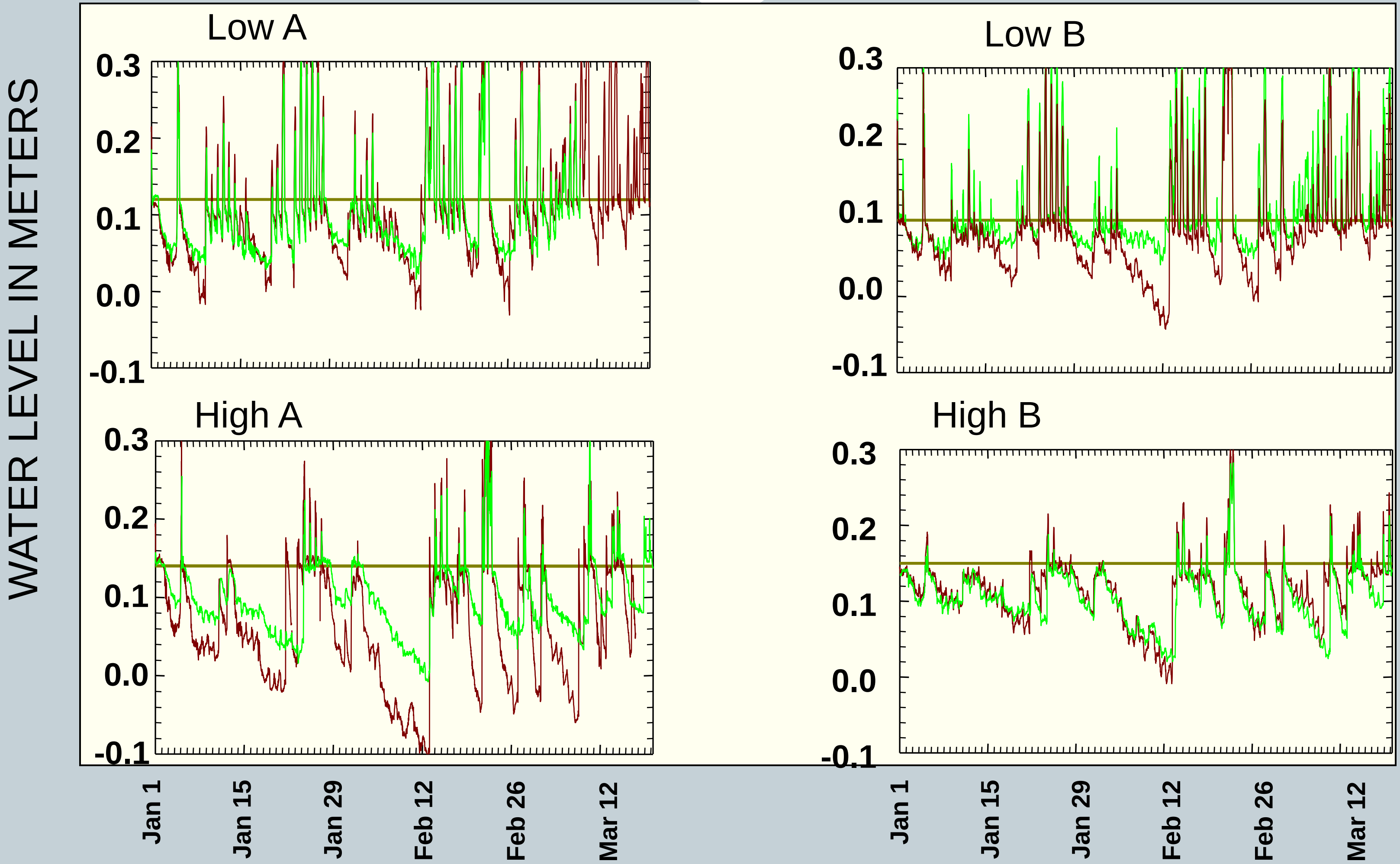
- In field: compare relative elevations, soil salinity,
  drawdowns, specific yield

- In lab: soil acidification potential, metal release

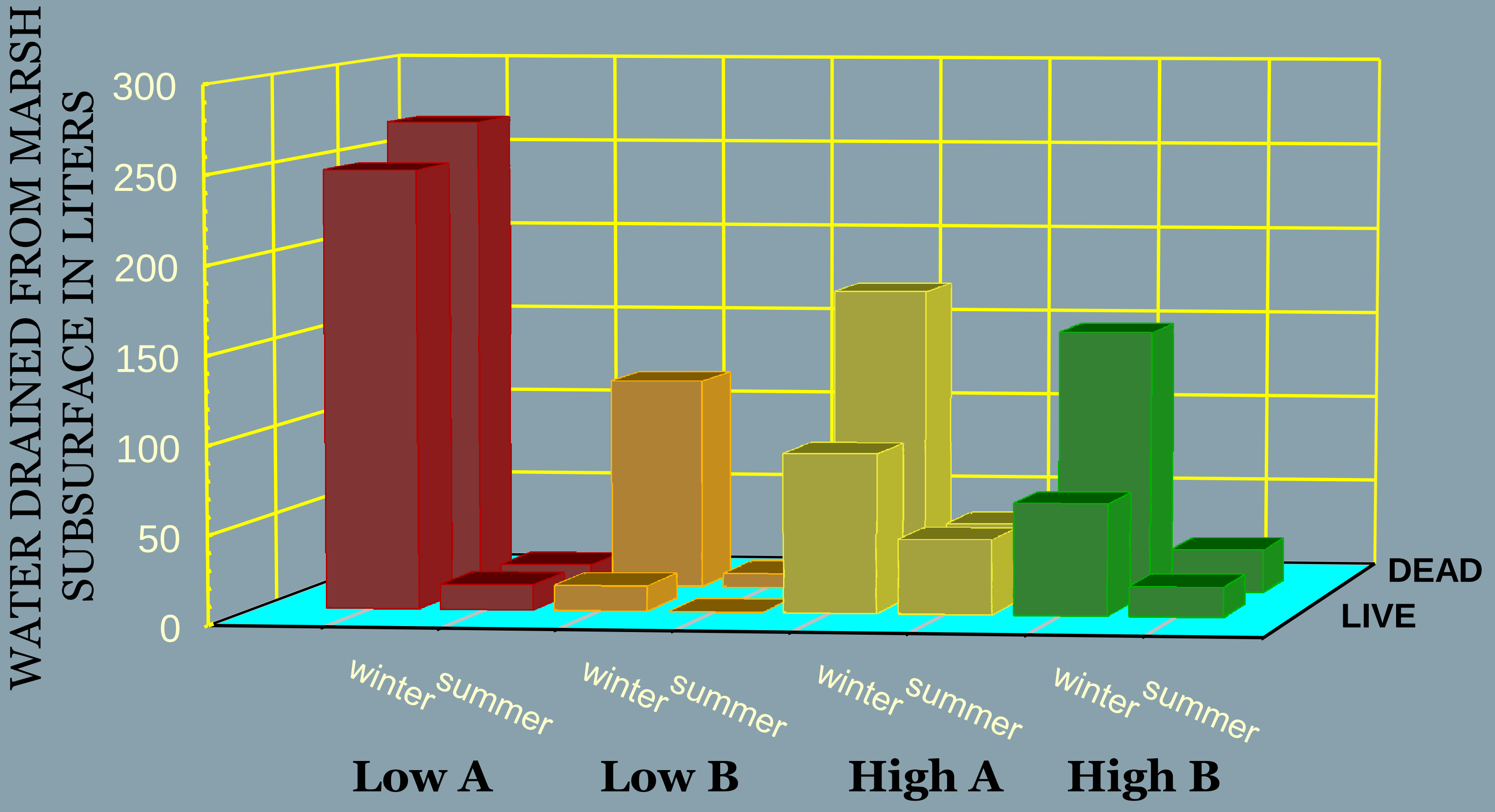
# Comparisons at paired interior marshes

| Parameter | High B | | High A | | Low B | | Low A | |
|---|---|---|---|---|---|---|---|---|
| | live | dead | live | dead | live | dead | live | dead |
| **Relative Elevation (cm)** | + 3 | | + 5 | | | +3 | +3 | |
| **Monthly Marsh flooding (%)** | 21 | 26 | 13 | 21 | 47 | 41 | 40 | 46 |
| **Maximum Drawdown (cm)** | 12 | 13.5 | 14 | 25 | 5 | 14 | 9 | 12 |
| **Specific Yield** | 0.03 | 0.08 | 0.03 | 0.03 | 0.09 | 0.10 | 0.18 | 0.17 |
| **Acidification Potential** | 2.6 | 2.8 | 2.9 | 3.2 | n.s | n.s | 4.5 | 3.3 |
| **Average Soil Salinity (ppt)** | 17.9 | 15.9 | 30.6 | 27.9 | 17.2 | 18.6 | 19.1 | 19.4 |

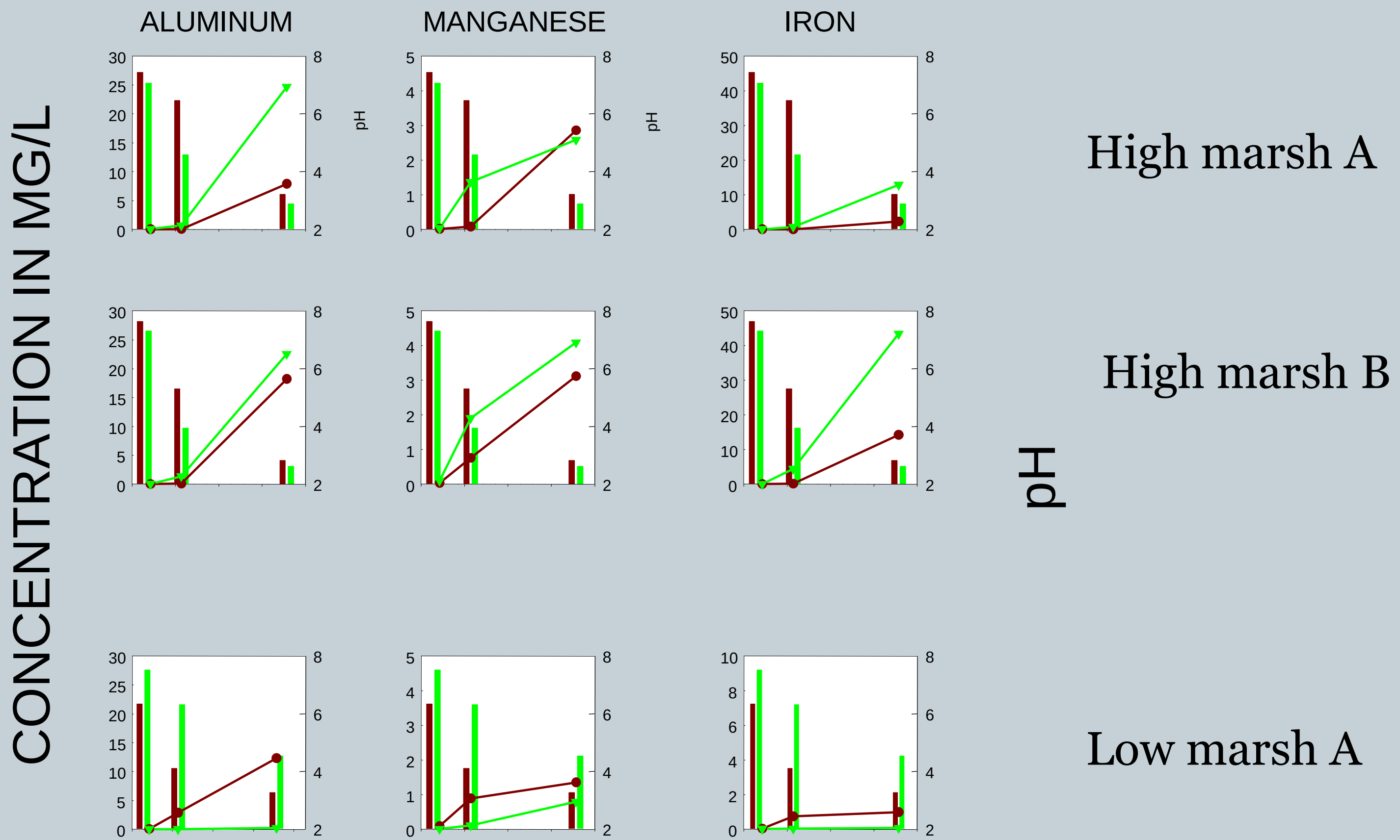
# Patterns of drawdown at paired marshes



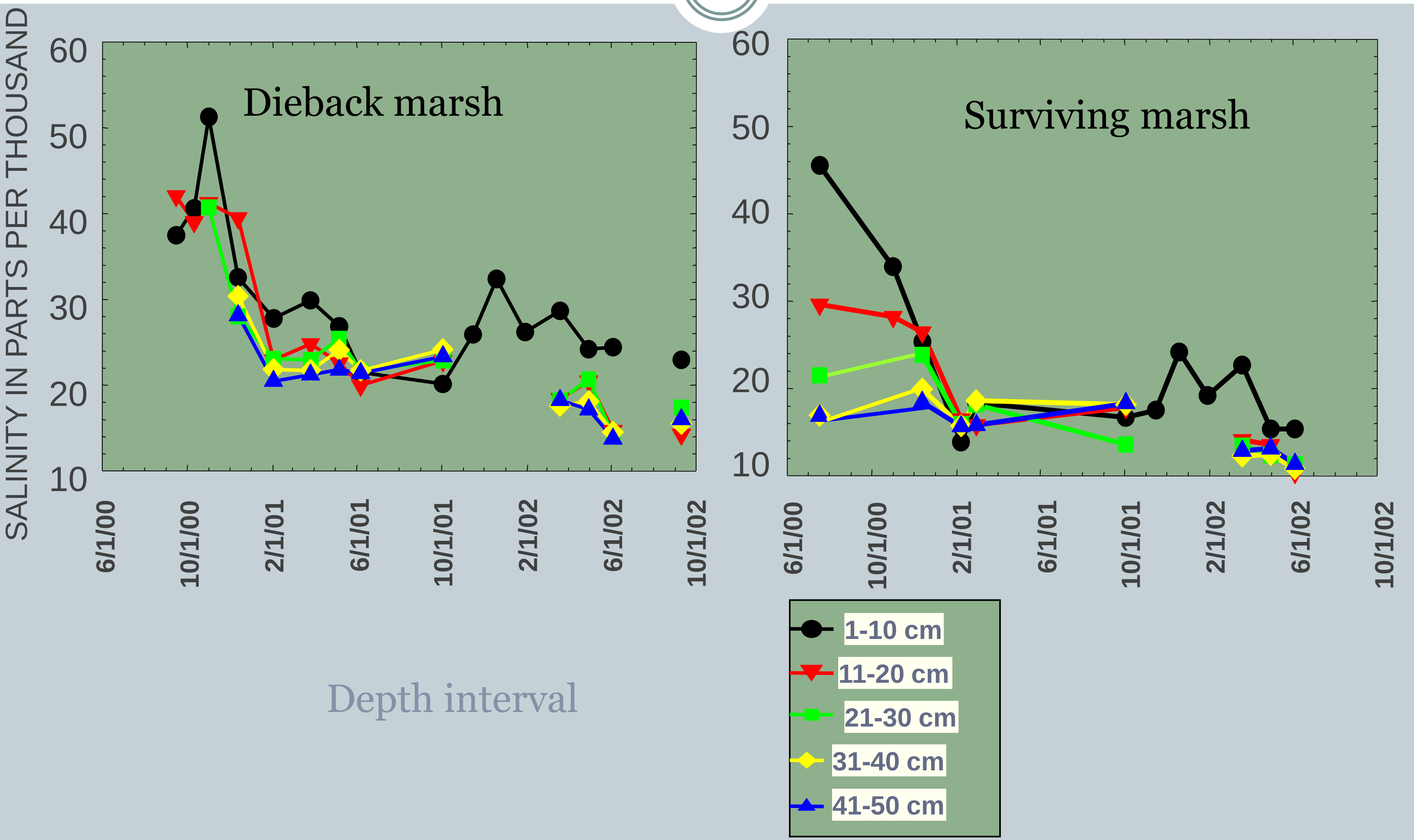
# Soil pore space volume during drawdowns



# Soil acidification potential and metal release



# Time Series of Soil Salinity in 10 cm increments (00-02)




Depth interval

# Drought as climate extreme

- Key to survival was ability to maintain supply of water during periods of no marsh flooding
- In one low elevation area dieback clearly related to soil acidification potential
- In remaining three areas (high and low marsh) soil acidification and/or bound water combined with high soil salinity likely contributed to plant mortality

# Low Marsh A dieback site recovery; recovery by seedlings at all sites



# 2009 Dieback

FIRST NOTICED IN FEBRUARY 2009, BEFORE NEW GROWTH

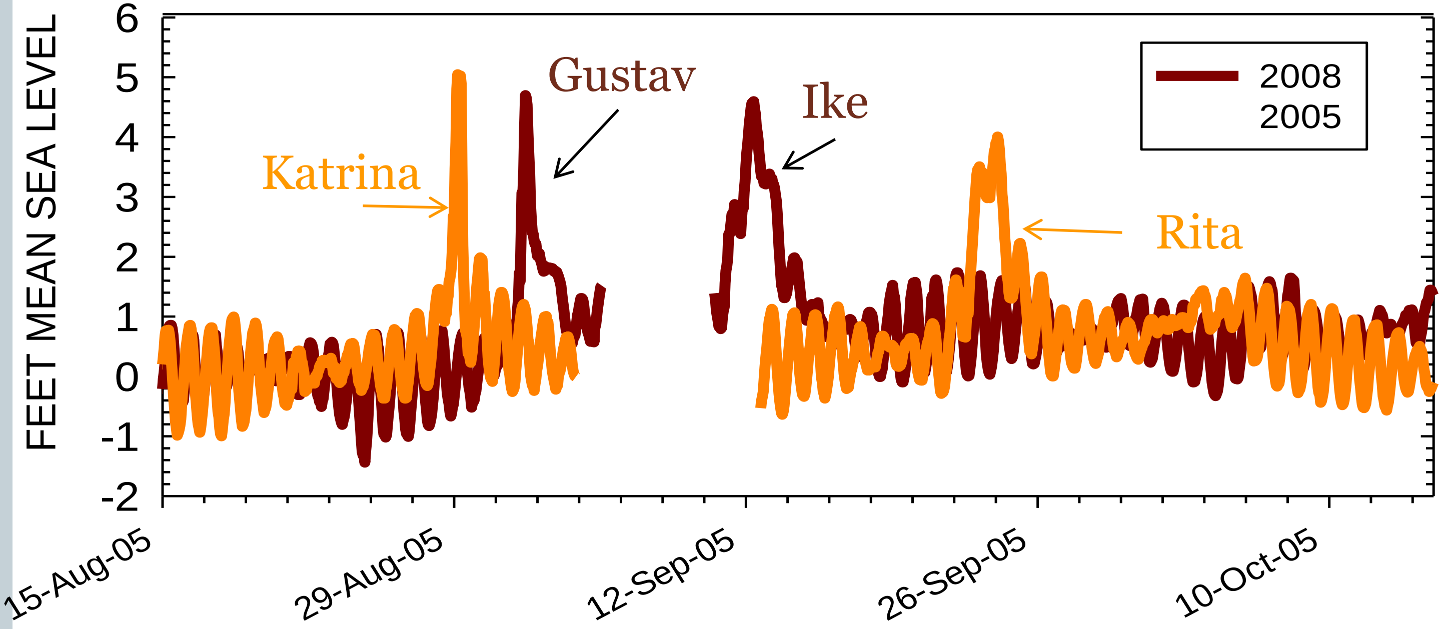
# 2009 dieback: limited to low elevation marsh

Dieback in interior areas

*S. alterniflora* and *Juncus roemerianus* died back

*J. roemerianus* no taller than *S. alt* where both survived

# In 2005 hurricanes were spaced further apart and base water levels may have been a bit lower




Hourly waterlevel at Grand Isle, August-October 2005 and 2008

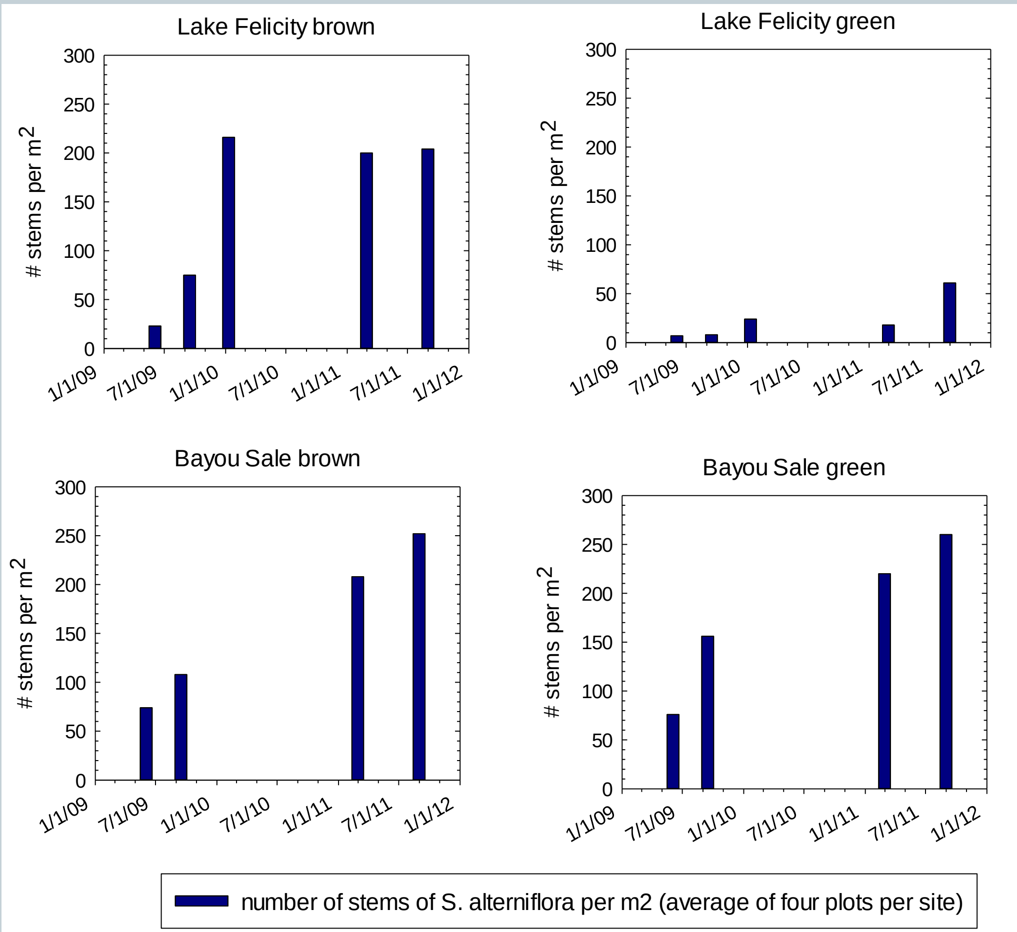
(Data from National Ocean Survey)

# Patterns of dieback

Within both low marsh sites, areas at about 18-20 cm NAVD88 elevation died back; areas > 24 cm NAVD88 survived; measurements made after dieback occurred

| Calculated % time flooded at indicated depths (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | >2.5 | >7.5 | >12.5 | >17.5 | >22.5 | >27.5 | >32.5 |
| 1 Aug- 31 Oct High marsh A | 41 | 32 | 24 | 17 | 12 | 9 | 7 |
| Low Marsh A | 62 | 52 | 41 | 31 | 22 | 17 | 12 |
| Sept 1-Oct 16 HM A | 63 | 51 | 39 | 32 | 22 | 17 | 13 |
| LM A | **80** | **71** | 59 | 56 | 37 | 30 | 22 |

# Recovery at 2009 dieback sites




Stem density of *S. alterniflora* over time at plots established during 2000 dieback

# Storm surge as climate extreme

- Dieback restricted to lower elevation marshes
- Both *S. alterniflora* and *J. roemerianus* affected
- Within a site, lowest elevation marshes affected
- Wild cards – spacing of storm surge may play a role as may exact storm path

# Re-growth 2009 to 2010 at Low marsh A

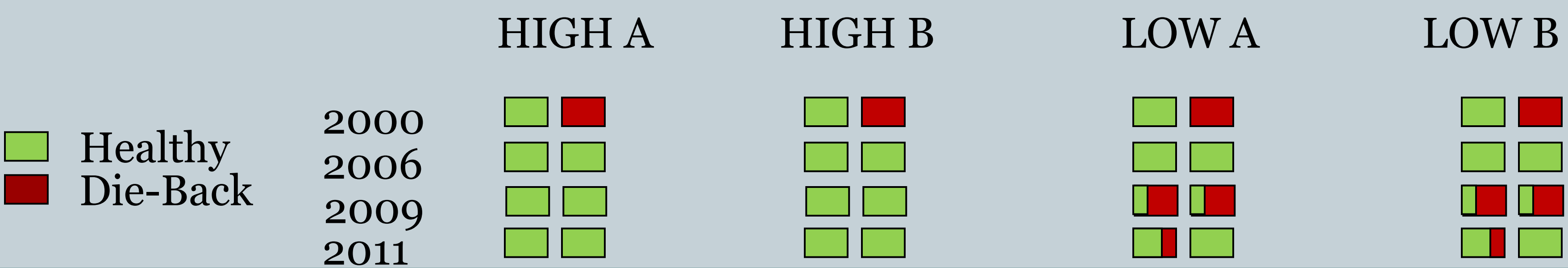

# Summary

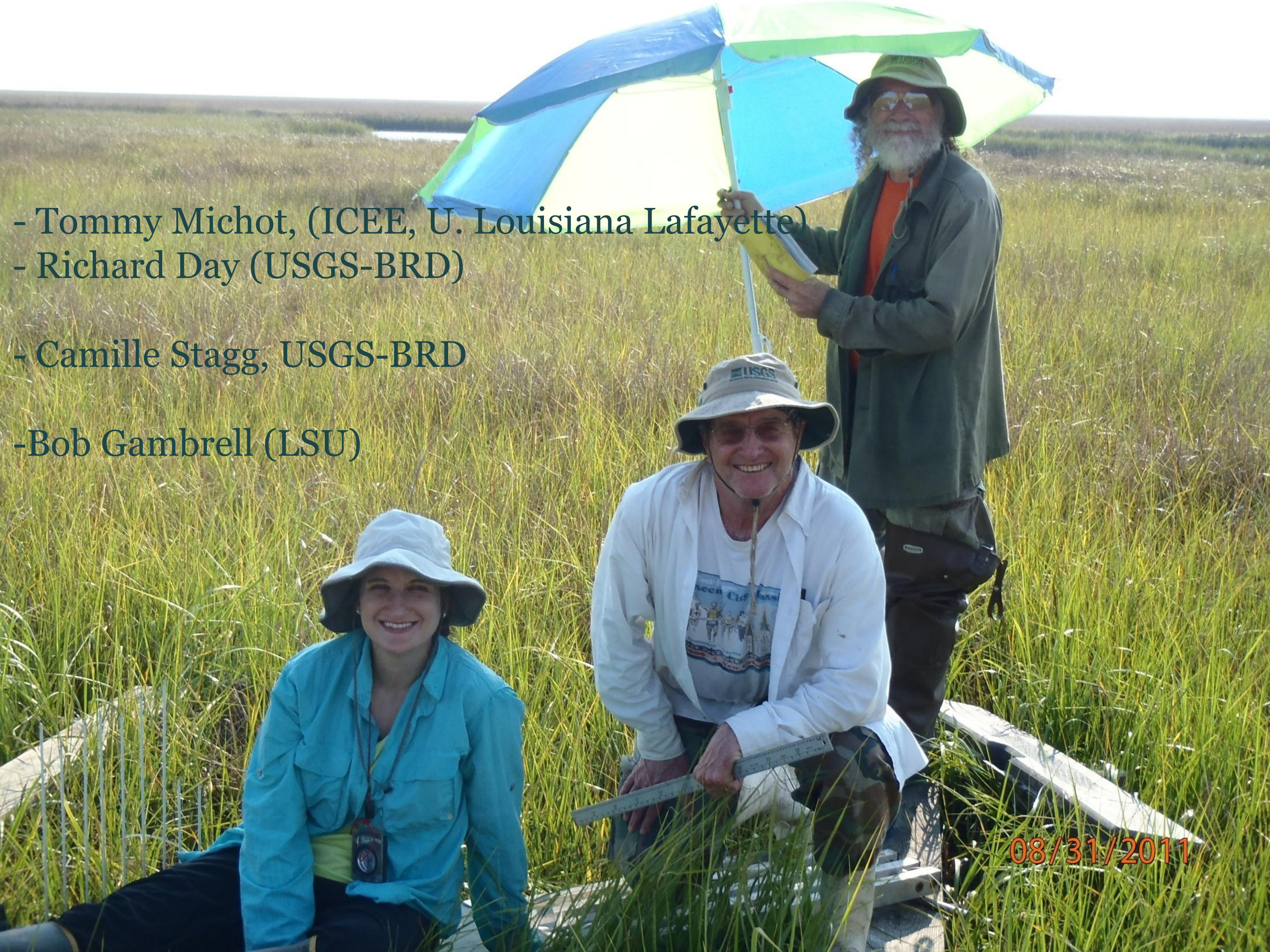
- DROUGHT AFFECTS MARSHES WITH DIFFERENT ELEVATIONS EQUALLY; STORM SURGE AFFECTS LOW LYING MARSHES

-CLIMATE PERTURBATIONS DON'T AFFECT PLANT SPECIES EQUALLY

- REGROWTH THROUGH SEEDLINGS (*S.ALTERNIFLORA)*

- UNEXPECTED RESILIENCE OF COASTAL LOUISIANA SALT MARSHES TO CLIMATE PERTURBATION




- Tommy Michot, (ICEE, U. Louisiana Lafayette)
- Richard Day (USGS-BRD)
- Camille Stagg, USGS-BRD
-Bob Gambrell (LSU)
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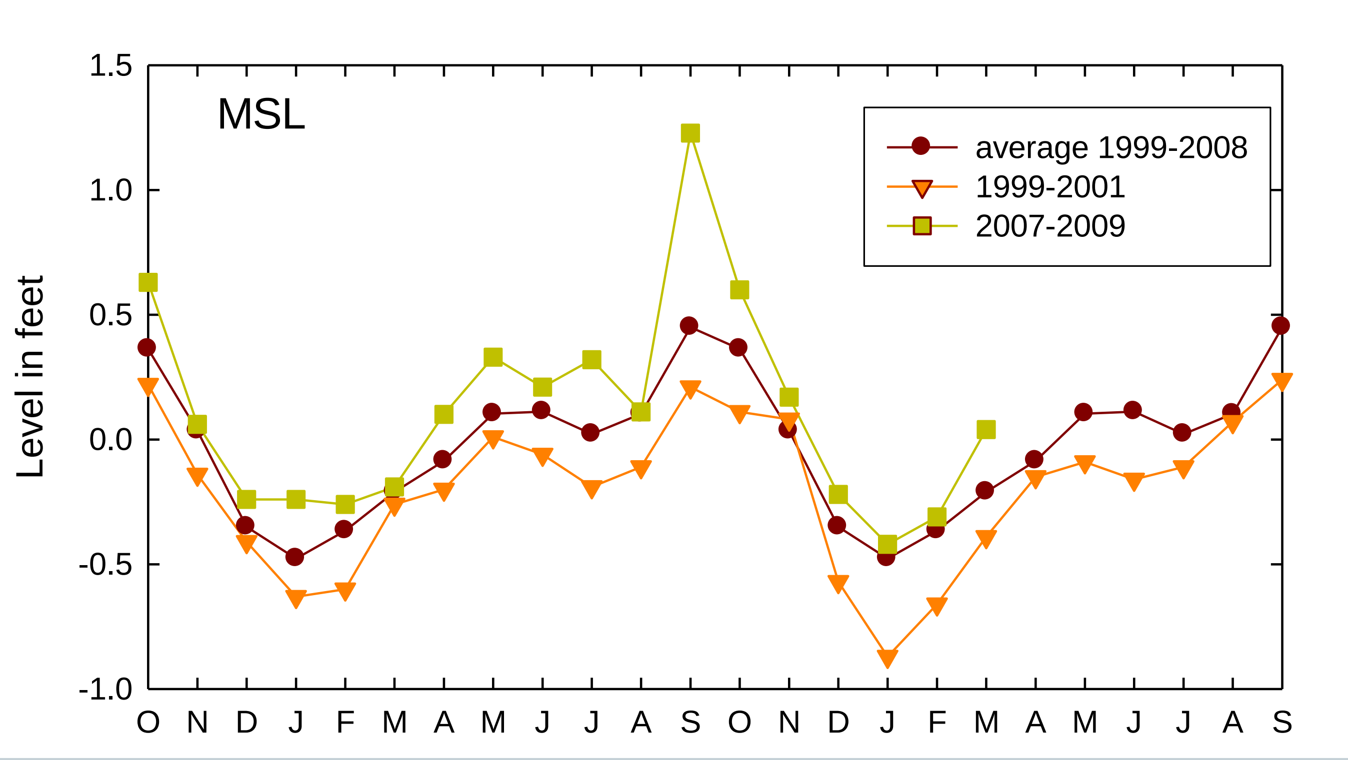


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