

## Tracking wetland sedimentation from the 2011 Mississippi River Flood

### Site Selection and Sampling

Aerial photography and maps were used to pre-select potential sampling sites in four basins (Atchafalaya Delta (AD), Terrebonne (TB), Barataria, (BA) and Mississippi River “Birdsfoot” Delta (MRD)) of Louisiana’s deltaic plain. Most sites were selected because of their close proximity to long-term monitoring stations (Coastwide Referencing Monitoring System (CRMS)) maintained by the State of Louisiana’s Office of Coastal Protection and Restoration ([http://lacoast.gov/crms\\_viewer/](http://lacoast.gov/crms_viewer/)). Potential sampling sites were aligned with CRMS stations to connect our sedimentation measurements with long-term accretion data – the CRMS network is the only monitoring network with extensive coastal coverage and long-term accretion data. Additional potential sites were selected in the AD and MRD basins to provide more extensive coverage in those key areas.

Forty-five of the potential sites were randomly selected for sampling and visited a single time over a 4-day period during the summer of 2011. Sites were accessed on June 21, 22, 23 (Eastern TB, BA, and MRD) and 27 (ARD and western TB) using a Bell 2063B Jet Ranger helicopter with fixed floats to allow marsh landings. Sampling sites were positioned at a consistent distance from waterways (~5 m) to enable direct comparisons in sedimentation among the four basins and assess basin-scale spatial variation in sediment deposition (Figure DR1).

At each site, the soil surface was identified, and 4 soil cores were collected with a piston corer (2 cm diameter x 15 cm length), which minimizes vertical compression. To ensure compression did not affect the depth measurements obtained from the piston corer, a fifth core was collected with a “mini-McCauley” corer, which cuts a half-section of a soil core in a horizontal plane against a stationary blade. The soil surface at all sampling sites was vegetated, although the small diameter of the corers enabled sampling between plant stems. Replicate cores were collected to account for local variability in sediment deposition that may have resulted due to variations in stem density of marsh vegetation and to assess within site sampling error.

Where present, the visually obvious layer of flood sediment was readily distinguishable as a recent deposit due to the lack of plant root ingrowth and its unconsolidated consistency. Flood sediment and the underlying pre-flood sediment layers differed in color and texture, and there was often a natural break in the sediment core at the boundary between the flood and pre-flood sediment layers. We acknowledge that we cannot identify the exact time of deposition of the recent sedimentation measured. Some of the surface sediment may have been deposited

before the flood (2011 was a high discharge year, even before the flood), or conversely, plant roots may have colonized sediments deposited during the initial stages of the flood, leading to an underestimation of flood sedimentation. Considering that all sites sampled in the flood survey were heavily vegetated and the flood occurred during the height of the growing season, it would be expected that root growth into a new sediment layer would occur rapidly. Numerous studies documenting the fast rate of marsh recolonization and root productivity (Redfield, 1972; Hartman, 1988; Blum and Christian, 2004; Liu and Yu, 2009; McKee and Cherry, 2009; Mayence and Hester, 2011) lead to the logical assumption that sampled sediment lacking ingrown roots was deposited very recently ( $< 2$  mo).

There was no systematic variation in depth measurements between the piston and mini-McCauley corer, so the depth of the flood sediment layer from all five cores was averaged to provide a mean value for each sampling site. The four piston cores were divided at the boundary between the flood and pre-flood sediment and carefully bagged separately for further analysis. When no obvious flood sediment layer was present (or minimal), the upper 2 cm was sampled for comparison with the underlying sediment. Additionally, surface and pore water samples were collected at each site with a sipper device and measured for salinity in the field with a refractometer (Table DR1). The dominant vegetation at each site was also identified to species and recorded (Table DR2).

## **Laboratory Analyses**

Sediment samples were analyzed for lithological (bulk density, organic matter content, grain size distribution), chemical (stable carbon isotopes of bulk sedimentary organic matter), and biological (diatoms) characteristics (Table DR1, DR3, DR4; Figure DR5, DR6). Half of the sediment samples ( $n = 2$  cores  $\times$  2 depths per site) were weighed wet, dried in an oven at 60 °C to constant mass, and reweighed. The standard method of (Noorany, 1984) was used to calculate dry bulk density as the mass of dry soil divided by the volume of the sample and corrected for salinity. Percent organic matter content was determined by ashing in a muffle furnace at 550 °C for 6 h (Loss on Ignition (LOI)). The remaining soil samples were used for determination of grain size distribution, diatom identification and analysis of bulk organic carbon isotope chemistry ( $\delta^{13}\text{C}$ ). Grain size distribution was measured on samples pretreated with 20%  $\text{H}_2\text{O}_2$  (to remove organic material) using a LS320 Beckman Coulter laser particle size analyzer (Allen and Thornley, 2004; Hawkes et al., 2007). Sediment sorting was calculated by:  $(d_{90}-d_{10})/d_{50}$ , where  $d_n$  is the  $n^{\text{th}}$  percentile of the cumulative distribution function.

Carbon isotope samples were acidified with 1M hydrochloric acid and left for 10 h to allow inorganic carbon to be liberated as  $\text{CO}_2$ . The samples were neutralized by repetitive washing with distilled water and were subsequently oven dried at 60 °C prior to  $\delta^{13}\text{C}$  analysis.  $^{13}\text{C}/^{12}\text{C}$  analyses were performed on powdered samples by combustion in a Europa

Scientific elemental analyzer coupled on-line to a Europa Scientific 20-20 isotope ratio mass spectrometer (IRMS), which was set to simultaneously measure isotopomers of CO<sub>2</sub> at m/z 44, 45, and 46. The reference material used during  $\delta^{13}\text{C}$  analysis was IA-R001 (wheat flour,  $\delta^{13}\text{C}_{\text{V-PDB}} = -26.43 \text{ ‰}$ ). For quality control purposes check samples of IA-R001, IA-R005 (beet sugar,  $\delta^{13}\text{C}_{\text{V-PDB}} = -26.03 \text{ ‰}$ ) and IA-R006 (cane sugar,  $\delta^{13}\text{C}_{\text{V-PDB}} = -11.64 \text{ ‰}$ ) were analyzed during batch analysis of the samples. IA-R001, IA-R005 and IA-R006 are calibrated against and traceable to IAEA-CH-6 (sucrose,  $\delta^{13}\text{C}_{\text{V-PDB}} = -10.43 \text{ ‰}$ ). IAEA-CH-6 is an inter-laboratory comparison standard distributed by the International Atomic Energy Agency (IAEA), Vienna.

A subset of samples ( $n = 6 \text{ sites} \times 2 \text{ depths per basin}$ ) with a distinct flood deposit was targeted for diatom analysis. Cores were subsampled uniformly along a vertical plane, and samples were prepared following Academy of Natural Sciences, Philadelphia standard (Charles et al., 2002). Organic matter was removed from samples by treatment with 70% nitric acid and digestion in a microwave apparatus. Each digested sample was dripped on a cover slip at appropriate concentrations for its mineral sediment density, dried overnight, and mounted on a slide using the high refractive index medium Naphrax<sup>TM</sup>. 100 diatom frustules were counted and classified as either centric or pennate on the basis of their morphology. To confirm habitat preferences of the observed centric/pennate diatoms and provide a qualitative description of flood diatom assemblages, one site from each basin ( $n = 2 \text{ depths} \times 4 \text{ sites}$ ) was selected for taxonomic identification to species level, and 100 diatom valves were identified using published diatom references (Krammer and Lange-Bertalot, 1991; Lange-Bertalot, 2002; Witkowski et al., 2000). All diatom counts were performed under 1000x magnification.

### **Sediment Volume Calculations**

The total volume of sediment deposited in the AD and MRD basins was calculated by multiplying the average basin accumulation by the most recent 2010 land cover estimates, determined from careful imagery analysis by Couvillion et al. (2011) (Table 1). Volume calculations did not include estimates for the TB and BA basins because the flood minimally affected these areas and coverage of sampling points was insufficient to extrapolate to the rest of the basin areas. Based on the presence of sediment-laden coastal waters surrounding the entire MRD as seen in MODIS satellite images during the flood (where the presence of persistent sediment plumes corresponds well to locations with greater observed deposition; Figure DR2), measured sedimentation rates from the western portion of the MRD were extrapolated to the entire basin. We recognize, however, that this assumption may over- or underestimate the true value in the MRD. Following Turner et al. (2006), in cases where the depth of the flood sediment was less than 0.5 cm, a zero value was used for site accumulation in calculations of mean basin accumulation. This conservative approach was adopted to enable comparisons with their estimates of hurricane-induced sedimentation and account for uncertainties with the sampling method.

We acknowledge that the reported volumes are basic estimates that may over- or underestimate the total deposition volume. To obtain more accurate values would require detailed sampling on a finer scale to account for spatial variations in factors that affect sediment deposition, such as vegetation type and density, distance to source, barriers to surface flows, and post-depositional reworking and erosion by waves or tides. We demonstrate, however, that our sampling points do account for variations in elevation. By plotting our sampling points on a digital elevation model for southern Louisiana (Love et al., 2010), we find that our sites cover a range in elevation, and further, that sediment deposition does not correlate with sample elevation (Figure DR3).

## **Statistical Analyses**

Marsh sediment data were analyzed using JMP (Version 9.0.0, SAS 2010). Flood sediment depth and mass accumulation were analyzed with a one-way ANOVA using “basin” as the grouping factor (Table DR5). Median grain size, sorting, bulk density, percent organic matter, carbon isotope composition and centric:pennate diatom ratio data were analyzed with a repeated measures ANOVA using basin as the grouping factor and depth (flood, pre-flood) as the repeated measure (Table DR6). Data were log-transformed where necessary to meet assumptions of ANOVA (equal variance, normality). In a few cases, data outliers were identified (Mahalanobis distance) and excluded from analysis. When a significant effect was found, differences among multiple means were identified with Tukey’s HSD.

Porewater salinity and sediment depth and accumulation varied significantly across basins (Table DR5). Sediment characteristic data were analyzed with and without sites with no visually identifiable flood deposit (sediment depth < 0.5 cm) excluded. There were significant differences across basins in carbon isotope values regardless of whether sites were excluded (see main text for further discussion). When those cores lacking a distinct flood layer were not excluded, there were no differences across basins in the remaining characteristics, whereas when only samples with a distinct flood layer were examined, there were significant differences in organic matter content and median grain size (Table DR6). There were significant depth variations in bulk density, organic matter content and centric:pennate ratio. Pre-flood sediments had a higher bulk density and lower organic matter content than the deposits above. Because this depth variation was observed in all basins and is consistent with processes associated with shallow compaction and organic matter stabilization in the marsh subsurface, it is likely not a lasting distinguishing feature of flood sediments. Only the centric:pennate ratio exhibited a significant basin x depth interaction, where there was a greater increase in centric:pennate ratio in AD and MRD sediments compared to the intervening TB and BA basins, which supports the contention that the observed increase in centric diatoms was due to factor(s) related to the flood (i.e., increased connectivity with the river and inundation over the marsh surface).

We performed factor analysis to simplify the dataset because a number of the variables were correlated (Figure DR4). Analysis was performed on the lithological and chemical characteristics of sites with an obvious flood sediment deposit ( $> 0.5$  cm depth,  $n = 29$  sites). We extracted two factors with eigenvalues greater than 1 that accounted for 74% of the variance in the data. The first factor was interpreted as a grain size/organic matter content factor with high positive loadings of loss on ignition (LOI) and total organic carbon and high negative loadings of bulk density and median grain size. The second factor was interpreted as a salinity factor with high positive loadings of porewater salinity and stable carbon isotope values. Overall, grainsize/organic matter and salinity were low in the AD and MRD basins and high in the BA and TB basins; however, when factor scores were analyzed using a one-way ANOVA, there were no significant differences among basins identified for Factor 1, but there were significant differences identified among the AD, MRD, and BA and TB basins in Factor 2 (Figure DR4). Factor scores were also analyzed with a repeated measures ANOVA, and for both factors, there were no significant basin x depth interactions (Figure DR4).

We performed detrended canonical correspondence analysis (DCCA) using the Multivariate Statistics Package (MVSP, Kovach Computing Service, Anglesey, Wales) on the species occurring at greater than 2% abundance in flood and pre-flood sediment samples from a site in each basin to clarify the relationship between diatom assemblages and environmental variables (Birks, 1995; Figure DR6). Axis 1 represents a gradient across organic matter content (LOI) and porewater salinity, while Axis 2 reflects a gradient in grain size based on the sand, silt, and clay content of samples. The position of species on the DCCA biplot is corroborated by habitat preferences denoted in the literature (Vos and de Wolf, 1993; van Dam et al., 1994). Greatest differences in species assemblage occur between sites, which mostly appears to be driven by salinity. The flood sediment of the AD and MRD basins show the greatest similarity to one another, yet the largest relative dissimilarity between flood and pre-flood sediments in all sites. Species that plot near the flood sediments of the AD and MRD also show the greatest increase in abundance from pre-flood to flood sediment and help to define distinct flood taxa. While there are a number of other factors that could explain the observed shift in diatom assemblages, such as seasonal effects (Kulkarni et al., 2005) or eutrophication (Cooper et al., 1995), the highlighted changes in species composition occurred only in flood-affected basins.

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Table DR1. Characteristics of sediment deposited in marshes by basin and site number. Flood sediment (recent surface deposit or top 2 cm of sediment when no identifiable flood deposit was present) at each site was distinguished from pre-flood sediment (the underlying strata below) by lack of ingrown plant roots and a different color and consistency.

Basin	Site Number	Porewater	Average	Average	Bulk Density		Organic Matter		Median Grain		Sorting		$\delta^{13}\text{C}$ (‰) <sup>§</sup>	
		Salinity	Depth	Accumulation	( $\text{g cm}^{-3}$ ) <sup>§</sup>		(%) <sup>§</sup>		Size ( $\mu\text{m}$ )					
		(‰)	(cm)*	( $\text{g/cm}^2$ ) <sup>†</sup>	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood
Atchafalaya Delta	57	0	0.2	0.1	0.44	0.69	16.46	8.50	11.02	10.11	4.93	3.62	-26.98-28.16	
	58	0	2.7	3.2	1.19	1.15	3.86	4.60	14.56	17.42	2.73	3.76	-27.53-26.33	
	59	0	6.8	6.0	0.88	0.94	3.59	3.19	12.01	19.90	3.67	3.55	-25.90-25.72	
	60	0	0.3	0.1	0.50	0.57	11.93	11.91	11.48	17.34	4.10	4.12	-27.84-28.05	
	61	0	0.3	0.2	0.66	0.62	10.52	7.09	9.58	144.14	26.07	5.05	-28.08-27.64	
	62	0	6.5	4.3	0.66	1.40	4.88	2.99	35.82	84.54	2.33	1.26	-27.20-26.50	
	63	0	1.7	1.1	0.67	0.98	4.70	5.12	14.85	13.55	2.51	3.00	-25.74-25.92	
	64	1	0.2	0.1	0.40	0.70	17.03	6.40	24.47	14.85	3.11	3.89	-26.80-26.81	
	65	0	8.3	2.3	0.27	0.27	19.12	27.16	6.78	8.94	7.67	20.25	-29.09-28.95	
	66	0	0.2	0.1	0.26	0.45	22.56	22.89	6.05	14.69	3.93	5.36	-27.98-28.64	
	67	0	2.1	1.0	0.46	0.76	8.04	5.25	7.81	7.24	4.99	4.58	-27.62-27.09	
	81	0	2.6	1.7	0.66	0.73			6.74	5.50	4.76	5.55	-27.76-27.04	
	82	0	2.6	1.3	0.51	0.71	9.19	6.51	10.39	8.45	6.36	3.68	-26.63-27.52	
	83	0	2.0	1.1	0.55	0.69	9.26	5.77	18.27	29.83	3.46	3.29	-27.62-27.63	
	84	0	0.0	0.0	2.02	1.57	5.89	6.43	137.6	6.35	1.20	1.09	-26.54-26.50	
Terrebonne	35	30	0.7	0.4	0.54	0.76	12.95	9.84	7.03	12.52	3.57	3.22	-16.96-17.23	
	36	30	0.2	0.3	1.37	0.98	4.59	5.25	24.47	31.72	3.67	3.13	-18.17-19.93	
	37	36	0.2	0.3	1.38	0.99	4.01	5.65	29.83	21.35	5.65	5.16	-21.43-19.41	
	38	20	0.8	0.9	1.24	1.25	5.12	3.26	12.60	28.64	4.19	2.67	-18.09-18.47	
	41	15	0.4	0.2	0.55	0.33	17.75	26.27	15.78	11.65	5.41	5.80	-21.95-17.48	
	45	18	0.5	0.2	0.45	0.46	10.19	9.86	11.65	8.46	5.59	5.65	-20.45-18.31	
	54	14	2.4	0.6	0.27	0.23	17.03	19.02	5.58	14.72	6.01	7.21	-20.97-19.37	
	55	20	1.7	0.7	0.41	0.59	8.61	7.12	6.28	10.99	6.40	4.61	-18.23-19.46	
	56	0	0.3	0.1	0.37	0.43	16.60	12.72	21.35	21.99	6.81	5.74	-22.87-25.82	
	72	0	0.4	0.2	0.40	0.41	15.54	13.98	5.09	11.45	5.52	7.83	-23.91-26.76	
	73	0	0.2	0.3	1.17	0.81	6.26	7.48	7.70	11.13	2.22	2.15	-23.63-23.51	
	75	1	0.2	0.1	0.33	0.34	24.17	27.61	6.67	16.21	11.00	7.35	-26.20-25.40	
	77	0	0.6	0.4	0.70	0.55	16.54	13.95	5.58	10.07	4.37	4.64	-24.40-26.00	
	78	0	1.4	1.2	0.85	0.72	5.82	7.84	16.86	49.79	4.73	1.93	-27.12-26.76	



Table DR1. (cont)

Basin	Site Number	Porewater Salinity (‰)	Average Depth (cm)*	Average Accumulation (g cm <sup>-2</sup> ) <sup>†</sup>	Bulk Density (g cm <sup>-3</sup> ) <sup>§</sup>		Organic Matter (%) <sup>§</sup>		Median Grain Size (μm)		Sorting		δ <sup>13</sup> C (‰) <sup>§</sup>	
					Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood
Barataria	1	1	1.4	1.0	0.68	0.51	21.02	17.39	32.51	52.32	3.66	2.06	-20.59-20.72	
	2	1	0.2	0.1	0.57	0.66	11.81	11.19	25.54	12.36	3.58	6.39	-23.99-24.50	
	3	0.5	0.0	0.0	1.91	1.68	3.04	2.44	97.64	76.68	1.53	1.70	-23.98-24.61	
	4	33	1.2	0.3	0.23	0.37	39.87	21.21	15.19	11.71	7.68	6.09	-17.93-17.03	
	5	30	0.3	0.2	0.73	1.16	6.33	2.92	31.17	91.14	4.27	1.68	-20.23-19.92	
	6	28	1.3	0.4	0.34	0.45	17.12	15.59	6.33	2.41	12.28	5.76	-19.96-20.73	
	8	32	1.2	0.5	0.40	0.61	16.55	13.23	19.60	17.48	8.22	5.47	-21.13-19.90	
	30	22	0.9	0.3	0.31	0.41	18.93	21.00	36.09	11.48	6.13	5.48	-17.39-17.32	
	10	22	0.3	0.1	0.54	0.55	16.07	12.59	6.09	6.06	3.78	5.94	-17.70-18.20	
Mississippi River Delta	11	6	1.1	0.5	0.40	0.55	11.83	11.20	9.05	16.56	3.58	3.67	-18.78-20.17	
	13	7	0.4	0.3	0.58	0.50	15.30	10.02	8.55	7.69	4.62	9.13	-18.98-18.76	
	14	0	1.6	0.6	0.34	0.38	13.15	18.07	7.29	8.09	4.52	4.75	-26.74-26.08	
	15	14	1.5	1.3	0.87	1.31	8.19	5.50	24.56	22.22	6.53	4.75	-21.06-21.52	
	16	28	1.2	0.8	0.64	0.89	5.42	4.41	16.55	12.39	13.90	3.19	-20.53-18.67	
	17	12	1.0	0.8	0.79	0.90	5.91	5.70	9.98	13.32	3.19	5.05	-16.64-16.21	
	18	28	3.5	3.7	1.06	1.84	3.49	1.63	125.8	154.82	1.57	1.16	-20.80-19.76	
	20	30	2.2	2.3	1.03	1.20	3.27	4.27	53.38	13.22	2.13	3.89	-21.18-19.93	

\*Average depth of the most recent sediment deposit (n = 5 per site)

<sup>†</sup> Mass accumulation at each site was calculated based on average depth x average bulk density of the flood sediment layer

<sup>§</sup> Average bulk density, percent organic content, δ<sup>13</sup>C (n = 2 per site).

Table DR2. Dominant vegetation recorded at each sampling site. Vegetation codes, species names, photosynthetic pathway (C3 vs. C4) and group (dicot vs. monocot) are listed to the right.

Basin	Site #	Dominant Co-dominant or sub-dominant			Vegetation Code	Name	Photosynthetic Pathway	Group
		1	2	3				
Atchafalaya Delta	57	PAHE	VILU		ALPH	<i>Alternanthera philoxeroides</i>	C3	Dicot
	58	COES	ALPH	PHAU	AVGE	<i>Avicennia germinans</i>	C3	Dicot
	59	ZIZ	ALPH	COES	COES	<i>Colocasia esculenta</i>	C3	Monocot
	60	PAHE	COES		CYP	<i>Cyperus sp.</i>	C4	Monocot
	61	SCCAL	CYP	TYPHA	DISP	<i>Distichlis spicata</i>	C4	Monocot
	62	ALPH	SALA	COES	Elsp	<i>Eleocharis sp.</i>	C3	Monocot
	63	COES	ALPH	LUPE	JURO	<i>Juncus roemerianus</i>	C3	Monocot
	64	ZIZ	SANI		LUPE	<i>Ludwigia peploides</i>	C3	Dicot
	65	ALPH	SALAT	ZIZ	PAHE	<i>Panicum hemitomon</i>	C3	Monocot
	66	PAHE	VILU	SCCA	PHAU	<i>Phragmites australis</i>	C3	Monocot
	67	ALPH	COES	ZIZ	POLYGsp	<i>Polygonum sp.</i>	C3	Dicot
	81	POLYGsp	ZIZ	VILU	SALA	<i>Sagittaria lancifolia</i>	C3	Dicot
	82	ALPH	ZIZ	SALAT	SALAT	<i>Sagittaria latifolia</i>	C3	Dicot
	83	ALPH	SANI	PHAU	SANI	<i>Salix nigra</i>	C3	Dicot
	84	SANI	sandbar along river		SCCAL	<i>Schoenoplectus californicus</i>	C3	Monocot
Terrebonne					SCRO	<i>Schoenoplectus robustus</i>	C3	Monocot
	35	SPAL	AVGE		SPAL	<i>Spartina alterniflora</i>	C4	Monocot
	36	SPAL	AVGE		SPPA	<i>Spartina patens</i>	C4	Monocot
	37	SPAL	AVGE		TYPHA	<i>Typha sp.</i>	C3	Monocot
	38	SPAL	AVGE		VILU	<i>Vigna luteola</i>	C3	Dicot
	41	SPAL			ZIZ	<i>Zizaniopsis miliacea</i>	C3	Monocot
	45	SPAL						
	54	SPPA	SCAM					
	55	SPAL	JURO	SCRO				
	56	SALA	VILU					
	72	SPPA	SPAL	JURO				
	73	SPAL	AVGE					
	75	SPAL	DISP					
	77	SPAL	JURO					
	78	SPAL						
Barataria	1	SPAL	AVGE					
	2	SPAL	JURO	AVGE				
	3	SPAL	AVGE					
	4	SPAL						
	5	DISP	SPAL					
	6	SPAL	JURO					
	8	SPAL	JURO					
Mississippi River Delta	30	SPAL	JURO					
	10	VILU	PHAU	COES				
	11	SALA	PHAU	COES				
	13	SALA	SPPA	PHAU				
	14	SALA	PHAU	Elsp				
	15	PHAU	LUPE	VILU				
	16	TYPHA	LUPE	ZIZ				
	17	SPAL	PHAU					
	18	SALA	PHAU					
	20	PHAU	TYPHA					

Table DR3. Ratio of centric:pennate diatoms in flood and pre-flood sediments (n = 6 sites per basin) and the percent change in centric:pennate ratio from pre-flood to flood sediments.

*Basin	Site #	Centric:Pennate ratio		Depth change in Centric:Pennate ratio (%)
		Flood	Pre-flood	
AD	59	0.85	0.34	152.3
AD	62	0.67	0.13	416.7
AD	65	0.27	0.22	22.8
AD	67	1.08	0.54	98.5
AD	81	0.83	0.32	158.7
AD	82	0.59	0.52	15.4
BA	1	0.37	0.32	16.8
BA	2	0.52	0.40	31.0
BA	4	0.26	0.40	-34.9
BA	5	0.96	1.10	-13.0
BA	8	6.14	6.33	-3.0
BA	30	0.22	0.20	11.7
MRD	11	0.59	0.19	208.3
MRD	15	2.35	0.58	302.5
MRD	16	1.33	0.63	111.5
MRD	17	1.86	1.00	85.7
MRD	18	0.22	0.20	11.2
MRD	20	1.83	1.23	48.6
TB	36	0.33	0.38	-13.1
TB	38	0.86	0.65	33.0
TB	45	1.13	1.55	-26.8
TB	55	3.63	1.15	215.5
TB	72	0.36	0.36	-0.9
TB	78	0.28	0.18	50.7

\*AD =Atchafalaya Delta; BA = Barataria; MRD = Mississippi River Delta; TB = Terrebonne

Table DR4. Diatom counts (# of valves) to species level in flood and pre-flood sediment from sites in each basin.

Species	Site 38 (TB)*		Site 1 (BA)*		Site 17 (MRD)*		Site 62 (AD)*		Total
	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	
<i>Achnanthes cf. hauckianum</i>	0	0	2	3	0	0	0	0	5
<i>Achnanthes sp. 1</i>	0	0	1	0	0	0	0	0	1
<i>Achnanthes sp. 2</i>	0	2	0	0	0	0	0	0	2
<i>Achnanthes sp. 3</i>	0	2	0	0	0	0	0	0	2
<i>Achnanthidium minutissima</i>	4	0	0	0	0	0	0	2	6
<i>Actinocyclus normanii fo. subsalsus</i>	0	4	0	2	2	0	5	3	16
<i>Actinoptychus senarius</i>	1	0	0	0	0	0	0	0	1
<i>Amphora delicatissima</i>	0	0	15	7	0	0	0	0	22
<i>Amphora holsatica</i>	7	0	1	0	0	0	0	0	8
<i>Amphora pediculus</i>	0	0	0	0	0	0	0	2	2
<i>Amphora spp.</i>	1	2	6	6	0	2	0	2	19
<i>Aulacoseira alpigena</i>	0	0	0	0	2	0	0	0	2
<i>Aulacoseira ambigua</i>	0	0	0	0	5	2	0	1	8
<i>Aulacoseira granulata</i>	0	0	0	0	0	1	0	0	1
<i>Aulacoseira granulata var. angustissima</i>	0	0	0	0	1	0	2	0	3
<i>Aulacoseira subborealis</i>	0	0	0	0	7	9	2	0	18
<i>Bacillaria paradoxa</i>	0	0	0	0	0	1	4	2	7
<i>Bidulphia sp. 1</i>	0	0	4	0	0	0	0	0	4
<i>Cocconeis neodiminuta</i>	1	0	0	9	0	0	0	0	10
<i>Cocconeis placentula var. euglypta</i>	0	0	2	1	0	0	0	2	5
<i>Cocconeis scutellum var. parva</i>	0	0	2	2	0	0	0	0	4
<i>Cocconeis sp. 1</i>	0	0	0	1	0	0	0	0	1
<i>Cosmioneis sp. 1</i>	0	0	0	2	0	0	0	0	2
<i>Craticula spp.</i>	2	2	2	0	0	0	0	0	6
<i>Cyclostephanos invisitatus</i>	0	0	0	0	2	1	3	0	6
<i>Cyclostephanos spp.</i>	2	2	0	0	0	4	1	0	9
<i>Cyclostephanos tholiformis</i>	0	0	0	0	1	6	1	0	8
<i>Cyclotella atomus</i>	3	10	3	4	6	8	3	0	37
<i>Cyclotella cryptica</i>	0	0	0	0	3	0	2	0	5
<i>Cyclotella hakansonniae</i>	3	0	2	0	0	0	0	0	5
<i>Cyclotella littoralis</i>	0	2	0	0	0	0	0	0	2
<i>Cyclotella meneghiniana</i>	0	1	0	0	13	0	5	1	20
<i>Cyclotella michiginiana</i>	0	0	3	0	0	0	0	0	3
<i>Cyclotella sp. 1</i>	0	2	2	1	0	0	0	0	5

Table DR4. (cont.)

Species	Site 38 (TB)*		Site 1 (BA)*		Site 17 (MRD)*		Site 62 (AD)*		Total
	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	
<i>Cyclotella</i> spp.	0	0	0	0	0	0	1	0	1
<i>Cymatosira belgica</i>	0	5	0	0	0	0	0	0	5
<i>Denticula neritica</i>	0	0	0	0	2	0	0	0	2
<i>Diadensis contenta</i>	0	0	0	0	0	0	2	0	2
<i>Diatoma moniliformis</i>	0	0	0	0	0	4	0	0	4
<i>Diatoma vulgaris</i>	0	0	0	0	0	2	0	0	2
<i>Diploneis parma</i>	1	0	4	1	0	0	0	0	6
<i>Discostella woltereckii</i>	0	0	0	0	0	2	0	0	2
<i>Eunotogramma laevis</i>	2	0	0	1	0	0	0	0	3
<i>Fallacia</i> cf. <i>pulchella</i>	0	2	0	0	0	0	0	0	2
<i>Fallacia</i> cf. <i>tenera</i>	0	0	0	2	0	0	0	0	2
<i>Fallacia forcipata</i>	0	0	4	2	0	0	0	0	6
<i>Fallacia pygmaea</i>	0	0	0	0	0	0	0	17	17
<i>Fallacia tenera</i>	0	6	0	0	0	0	0	0	6
<i>Fragilaria crotonensis</i>	0	0	0	0	4	0	0	0	4
<i>Fragilaria nitzschoides</i>	0	0	2	0	0	0	0	0	2
<i>Fragilaria punctiformis</i>	3	0	0	0	0	0	0	0	3
<i>Fragilaria</i> sp. 1	0	0	2	0	0	0	0	0	2
<i>Geissleria schoenfeldii</i>	2	0	0	0	0	0	0	0	2
<i>Gomphonema angustutum</i>	0	2	0	0	0	0	0	0	2
<i>Gomphonema parvulum</i>	0	0	0	0	0	0	0	2	2
<i>Gyrosigma peisonis</i>	2	4	0	0	0	0	0	2	8
<i>Hippodonta capitata</i>	0	0	0	0	0	0	2	0	2
<i>Melosira</i> sp. 1	0	0	0	2	0	0	0	0	2
<i>Navicula atomus</i>	0	0	2	3	0	0	0	0	5
<i>Navicula bremensis</i>	6	10	0	3	0	0	0	0	19
<i>Navicula capitellata</i>	0	0	0	0	0	0	2	0	2
<i>Navicula</i> cf. <i>erifuga</i>	4	0	0	0	0	0	0	0	4
<i>Navicula</i> cf. <i>flanatica</i>	0	0	0	2	0	0	0	0	2
<i>Navicula</i> cf. <i>platyventris</i>	2	2	6	2	0	0	0	0	12
<i>Navicula</i> cf. <i>submuralis</i>	0	0	2	0	0	0	0	0	2
<i>Navicula cryptocephala</i>	0	0	2	0	0	0	0	0	2
<i>Navicula erifuga</i>	0	0	0	0	2	0	16	25	43
<i>Navicula gregaria</i>	4	4	0	0	4	2	2	4	20

Table DR4. (cont.)

Species	Site 38 (TB)*		Site 1 (BA)*		Site 17 (MRD)*		Site 62 (AD)*		Total
	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	
<i>Navicula incertata</i>	3	0	0	0	0	0	0	0	3
<i>Navicula indifferens</i>	0	0	1	0	0	0	0	0	1
<i>Navicula microdigitoradiata</i>	2	0	0	0	0	2	0	0	4
<i>Navicula minima</i>	2	0	0	0	0	0	0	2	4
<i>Navicula perminuta</i>	2	0	9	7	2	8	0	2	30
<i>Navicula phylleptosoma</i>	0	2	0	0	0	2	0	0	4
<i>Navicula rostellata</i>	0	0	0	0	0	0	1	7	8
<i>Navicula salinarum</i>	0	0	0	0	0	8	0	0	8
<i>Navicula salinicola</i>	2	0	2	2	2	0	0	3	11
<i>Navicula shadei</i>	0	0	0	0	0	0	2	0	2
<i>Navicula sp. 1</i>	0	0	6	4	0	0	0	0	10
<i>Navicula sp. 2</i>	0	0	2	0	0	0	0	0	2
<i>Navicula sp. 3</i>	2	4	0	0	3	6	0	0	15
<i>Navicula sp. 4</i>	4	0	0	4	0	0	0	0	8
<i>Navicula sp. 5</i>	2	0	0	0	0	0	0	0	2
<i>Navicula sp. 6</i>	0	0	0	4	0	0	0	0	4
<i>Navicula sp. 8</i>	4	8	0	2	0	0	0	0	14
<i>Navicula sp. 10</i>	2	0	0	0	0	0	0	0	2
<i>Navicula sp. 11</i>	0	2	0	0	0	0	0	0	2
<i>Navicula spp.</i>	0	4	0	0	2	0	0	0	6
<i>Navicula sublucidula</i>	0	0	4	2	0	0	2	2	10
<i>Navicula vitabunda</i>	0	0	0	0	0	0	2	0	2
<i>Nitzschia angustatula</i>	0	0	0	0	0	0	2	0	2
<i>Nitzschia archibaldii</i>	1	0	0	0	4	0	4	2	11
<i>Nitzschia brevissima</i>	0	0	0	0	7	0	0	0	7
<i>Nitzschia clausii</i>	0	0	0	0	0	0	0	2	2
<i>Nitzschia communis</i>	2	0	0	0	0	0	0	0	2
<i>Nitzschia compressa</i>	2	0	1	0	0	0	0	0	3
<i>Nitzschia debilis</i>	0	0	0	0	8	4	0	0	12
<i>Nitzschia dissipata</i>	2	0	4	2	2	0	0	0	10
<i>Nitzschia dissipata var. media</i>	0	0	0	0	2	0	0	0	2
<i>Nitzschia fonticula</i>	0	0	0	0	0	0	2	0	2

Table DR4. (cont.)

Species	Site 38 (TB)*		Site 1 (BA)*		Site 17 (MRD)*		Site 62 (AD)*		Total
	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	
<i>Nitzschia frustulum</i>	4	0	0	4	0	0	0	0	8
<i>Nitzschia granulata</i>	1	0	0	0	0	0	0	0	1
<i>Nitzschia inconspicua</i>	0	0	0	0	0	0	2	2	4
<i>Nitzschia levidensis</i>	0	0	0	2	0	0	0	0	2
<i>Nitzschia liebetruthii</i>	6	2	4	6	0	2	2	0	22
<i>Nitzschia linearis</i>	0	0	0	0	0	2	0	0	2
<i>Nitzschia littoralis</i>	2	0	0	0	0	0	0	0	2
<i>Nitzschia microcephala</i>	0	0	0	0	0	2	2	0	4
<i>Nitzschia palea</i>	0	6	0	0	2	2	10	2	22
<i>Nitzschia panduriformis</i> var. <i>delicatula</i>	0	1	4	2	0	0	0	0	7
<i>Nitzschia parvula</i>	2	0	0	0	0	0	0	0	2
<i>Nitzschia pellucida</i>	0	0	0	0	0	2	0	0	2
<i>Nitzschia rosenstockii</i>	2	0	0	0	0	2	2	4	10
<i>Nitzschia sigma</i>	0	0	0	0	0	5	2	0	7
<i>Nitzschia</i> sp. 1	0	0	0	0	0	1	0	0	1
<i>Nitzschia tubicola</i>	0	0	0	0	0	2	0	0	2
<i>Placoneis</i> sp. 1	0	0	0	0	0	0	0	2	2
<i>Planothidium delicatulum</i>	1	0	0	9	0	0	0	0	10
<i>Rhopalodia</i> sp. 1	1	0	0	0	0	0	0	0	1
<i>Sellaphora mutata</i>	0	0	0	0	0	0	0	4	4
<i>Staurosira construens</i>	0	0	0	0	12	0	0	0	12
<i>Staurosira construens</i> var. <i>venter</i>	4	4	8	4	0	4	2	4	30
<i>Stephanodiscus agassizensis</i>	0	0	0	0	0	3	2	1	6
<i>Stephanodiscus hantzschii</i>	0	0	0	0	1	1	0	0	2
<i>Stephanodiscus minutulus</i>	0	1	0	0	4	1	2	1	9
<i>Stephanodiscus</i> spp.	0	0	0	0	4	0	0	0	4
<i>Surirella brebissonii</i>	0	0	0	0	0	0	2	0	2
<i>Surirella</i> sp. 1	0	0	0	0	0	0	1	0	1
<i>Thalassiosira exigua</i>	1	0	0	0	0	0	0	0	1
<i>Thalassiosira proschkiniae</i>	0	0	6	0	0	0	0	0	6
<i>Tryblionella apiculata</i>	0	0	0	0	0	2	2	0	4
Unknown Centric	1	0	0	0	0	0	0	0	1

Table DR4. (cont.)

Species	Site 38 (TB)*		Site 1 (BA)*		Site 17 (MRD)*		Site 62 (AD)*		Total
	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	Flood	Pre-flood	
<i>Unknown Centric I</i>	0	0	3	1	0	0	0	0	4
<i>Unknown Pennate</i>	0	8	4	0	0	0	2	2	16
Total:	107	106	127	111	109	105	101	107	873
Shannon-Weiner Diversity Index	3.61	3.15	3.33	3.35	3.08	3.27	3.30	2.87	
% Abundance of dominant diatom	6.54	9.43	11.81	8.11	11.93	8.57	15.84	23.36	
Total number of taxa	43	29	35	35	28	33	36	29	135
Total number of genera	18	15	14	14	10	12	14	17	40
<sup>#</sup> Siltation Index	60.75	51.89	41.73	49.55	36.70	50.48	61.39	76.64	

\*AD = Atchafalaya Delta; BA = Barataria; MRD = Mississippi River Delta; TB = Terrebonne

<sup>#</sup>Siltation Index = # of motile taxa



Table DR5. Summary of statistical analyses of marsh sedimentation data. One-way Analysis of Variance (ANOVA) with basin as the grouping factor was used to analyze porewater salinity, flood sediment depth and accumulation (depth x bulk density). Significant differences among means for the main effect of basin (Tukey's Honestly Significant Difference) are indicated by different letters.

Basin	n	Marsh Type	Porewater	s.e.	Sediment	s.e.	Sediment	s.e.
			Salinity (‰)		Depth (cm)		Accumulation (g cm <sup>-2</sup> )	
AD	14	Freshwater	<1a	<1	2.6a	0.7	1.61a	0.48
BA	8	Saline	23b	3	0.8ab	0.2	0.32ab	0.10
MRD	9	Freshwater	<1a	<1	1.4ab	0.3	1.14ab	0.39
TB	14	Saline	21b	3	0.7b	0.2	0.41b	0.08
Overall Mean	45		10.7	1.9	1.5	0.3	0.91	0.19
<b>Probability &gt; F</b>			<0.0001		0.0194		0.017	

\*AD =Atchafalaya Delta; BA = Barataria; MRD = Mississippi River Delta;  
TB = Terrebonne

Table DR6. Summary of statistical analyses of flood sediment characteristic data. Mean and standard error (s.e.) are listed only for sites with a distinct flood sediment layer. Repeated measures ANOVA was used to analyze bulk density, percent (%) organic matter, mean grain size, sorting,  $\delta^{13}\text{C}$  and centric:pennate (C:P) ratio. Depth (flood, pre-flood) was the repeated measure and basin was the grouping factor, where the interaction term indicates a different pattern across basins in depth variation. Significant differences among means for the main effect of basin (Tukey's Honestly Significant Difference) are indicated by different letters. Data outliers identified by Mahalanaobis Distance (based on flood x pre-flood correlation) were excluded for analysis of some variables: bulk density (2 outliers), organic matter (2 outliers), median grain size (3 outliers), sorting (3 outliers),  $\delta^{13}\text{C}$  (1 outlier), and centric:pennate ratio (3 outliers).

Basin*	n	Bulk Density (g cm <sup>-3</sup> )	s.e.	Organic Matter (%)	s.e.	Median Grain Size (μm)	s.e.	Sorting <sup>#</sup>	s.e.	$\delta^{13}\text{C}$ (‰)	s.e.	C:P ratio <sup>†</sup>	s.e.
AD	9	0.65	0.10	6a	1	11.4ab	2.5	3.9	0.6	-27.0a	0.4	0.73	0.23
BA	5	0.39	0.12	18b	2	21.9a	3.2	5.2	0.7	-18.6b	0.6	0.47	0.23
MRD	7	0.68	0.11	7a	1	13.5ab	3.2	4.5	0.8	-24.7c	0.5	1.36	0.21
TB	7	0.63	0.10	11a	1	9.4b	2.7	5	0.6	-19.1b	0.5	0.59	0.23
Overall Mean	29	0.60	0.05	10	1	13.4	1.6	4.6	0.3	-22.9	0.8	0.6	0.05
<b>Source of Variation</b>		Probability of > F; 'ns' indicates test was not significant at p<0.05 level											
Basin		ns		0.0002		0.0369		ns		0.0001		ns	
Depth		0.0011		0.0435		ns		0.0360		ns		0.006	
Basin x Depth		ns		ns		ns		ns		ns		0.009	

\*AD =Atchafalaya Delta; BA = Barataria; MRD = Mississippi River Delta; TB = Terrebonne

<sup>#</sup>Sorting was calculated by  $(d_{90}-d_{10})/d_{50}$ , where  $d_n$  is  $n^{\text{th}}$  percentile of cumulative distribution function.

<sup>†</sup> C:P = centric:pennate ratio for a subset of n = 6 sites per basin.

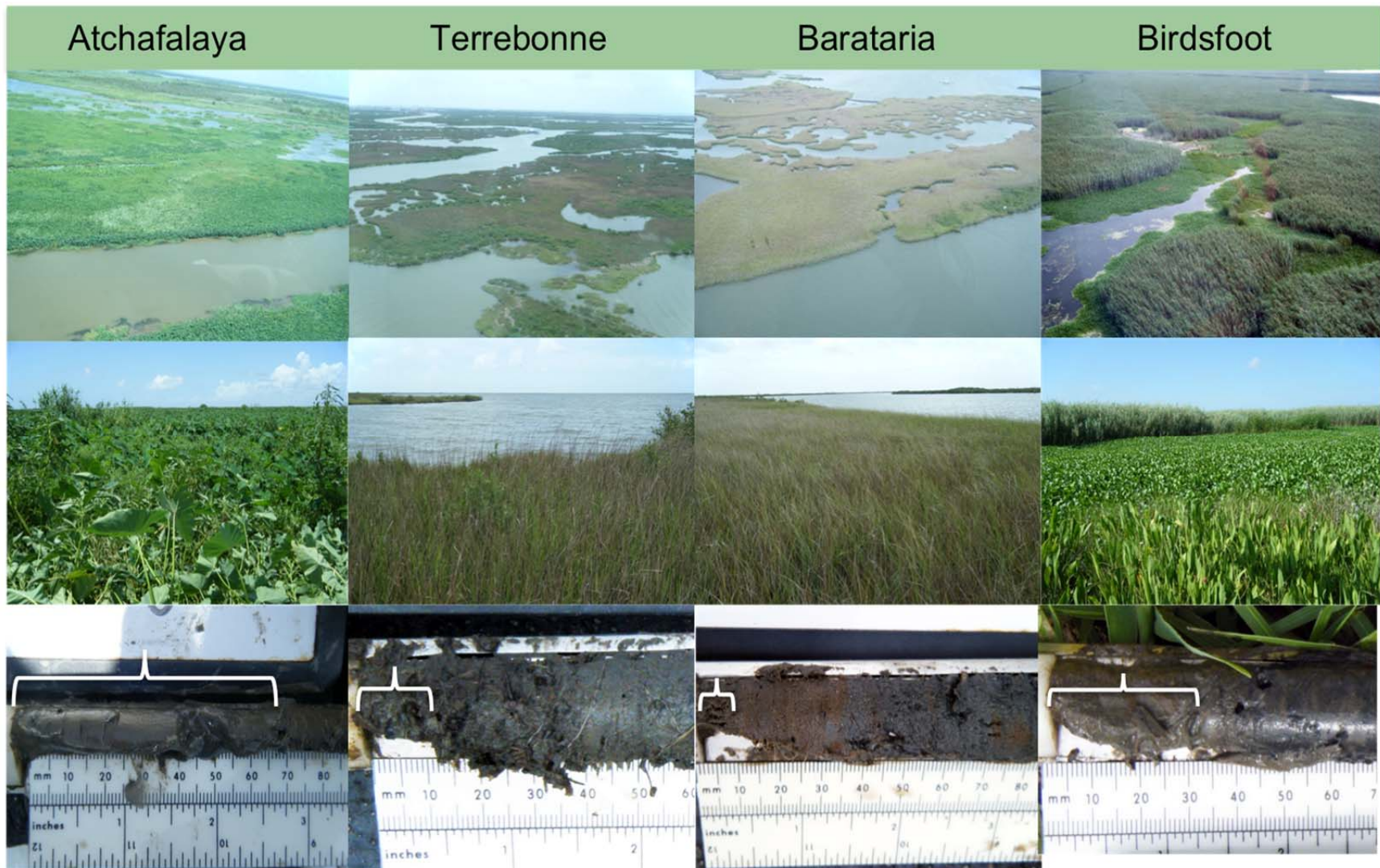


Figure DR1. Oblique aerial (top panels)) and ground (middle panels) views of representative sites and sediment cores (bottom panels) collected in four basins (Atchafalaya Delta, Terrebonne, Barataria, and Mississippi River Delta) in coastal Louisiana in June 2011. Recent sediment deposits are indicated on the sediment cores by white brackets.

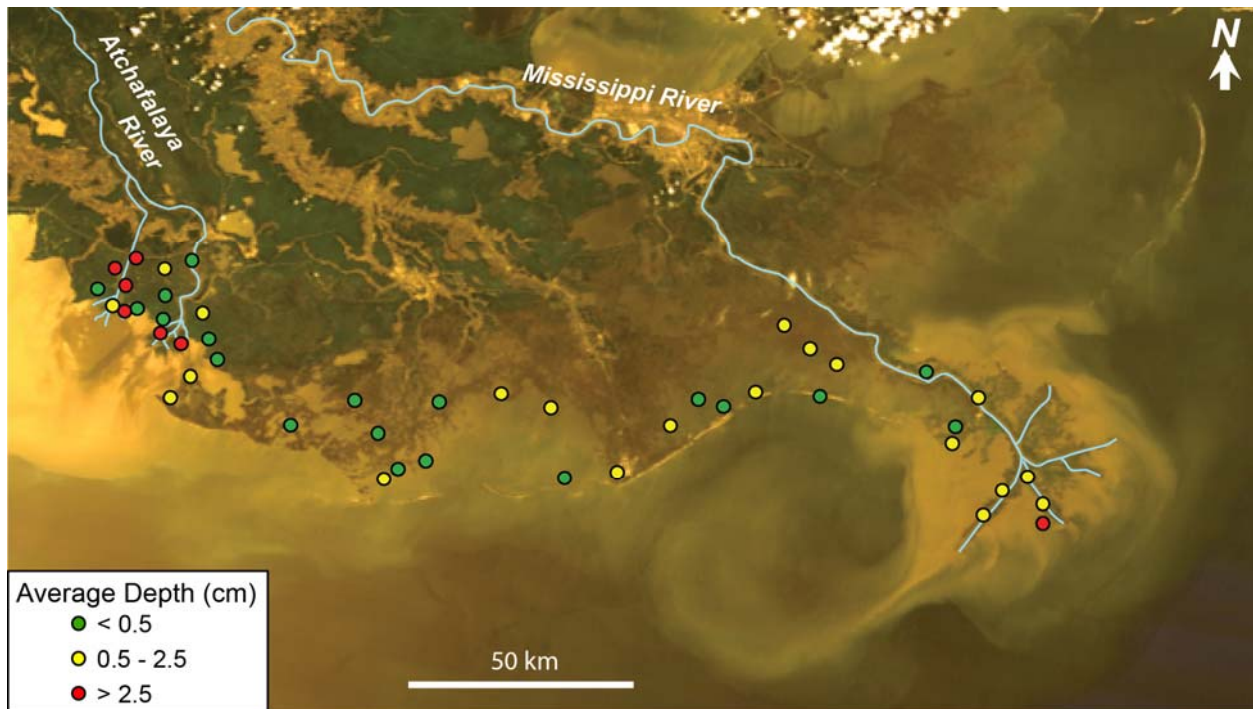


Figure DR2. Moderate Resolution Imaging Spectroradiometer (MODIS) ocean color image from 1 June, 2011, which shows the suspended sediment pattern along the deltaic coastline (data processed by Institute of Marine Remote Sensing, USF). There is a strong correspondence observed between sediment-laden coastal waters and observed deposition.

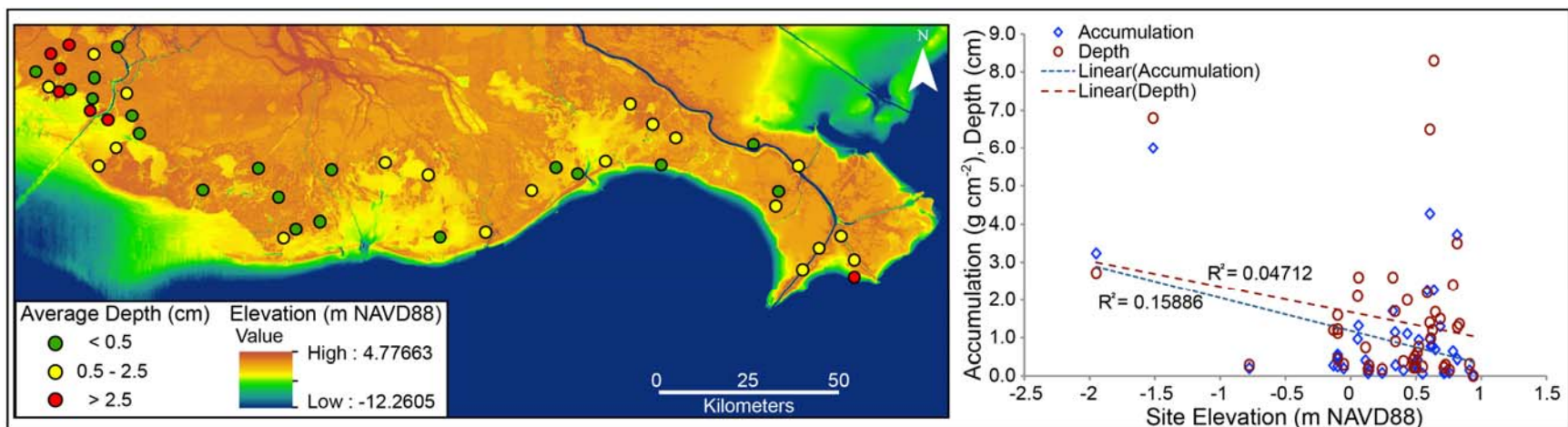


Figure DR3. Sediment deposition in relation to sampling station elevation. Sample elevation was extracted from a digital elevation model of Southern Louisiana (Love et al., 2010). No correlation is observed between elevation and measured deposition in this study.



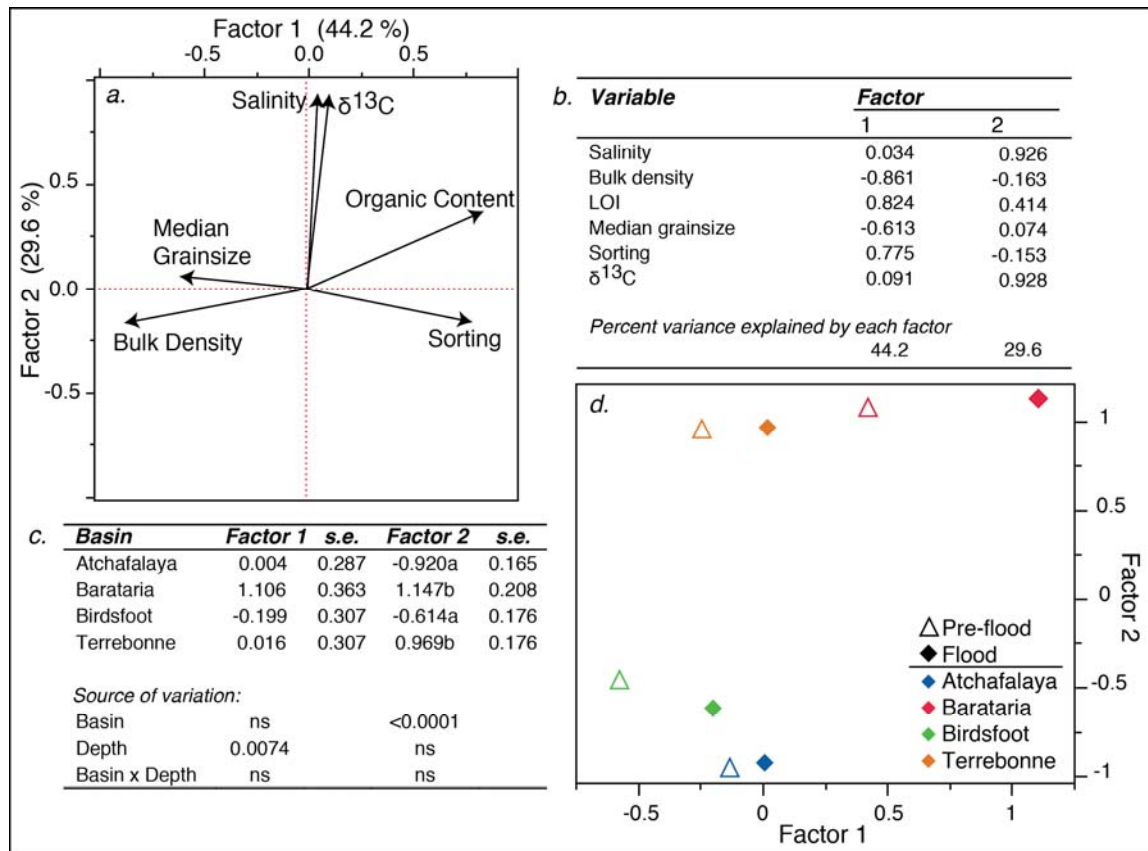


Figure DR4. Factor analysis of physical and chemical characteristics. a) Factor loading of environmental and sediment characteristics. b) Correlations of environmental and sediment characteristics with factors. c) Summary of Analysis of Variance (ANOVA) results for factors derived from characteristics (in a, c) across basins. Mean and standard error (s.e.) are listed for each basin, and probability  $> F$  is listed for each source of variation ( $p < 0.05$ ). See *Statistical Analyses* and Table DR6 for details of ANOVA analysis. d) Mean of factor scores for flood and pre-flood sediment from each basin.

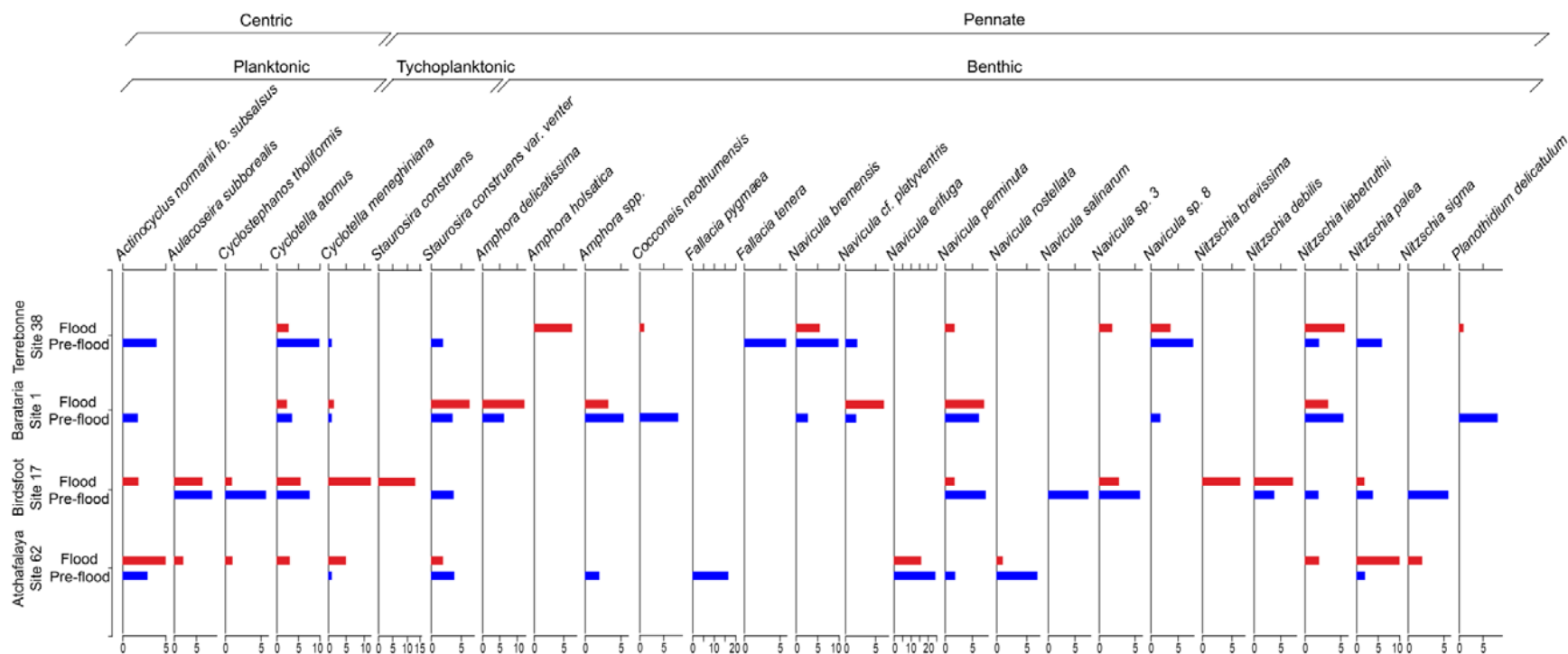


Figure DR5. Percent abundance of dominant diatom species (> 5% abundance within sample) organized by morphology (centric and pennate) and life form (planktonic, tycho planktonic, and benthic) from flood (red bars) and pre-flood sediments (blue bars) of the Atchafalaya Delta, Terrebonne, Barataria and Mississippi River Delta basins.

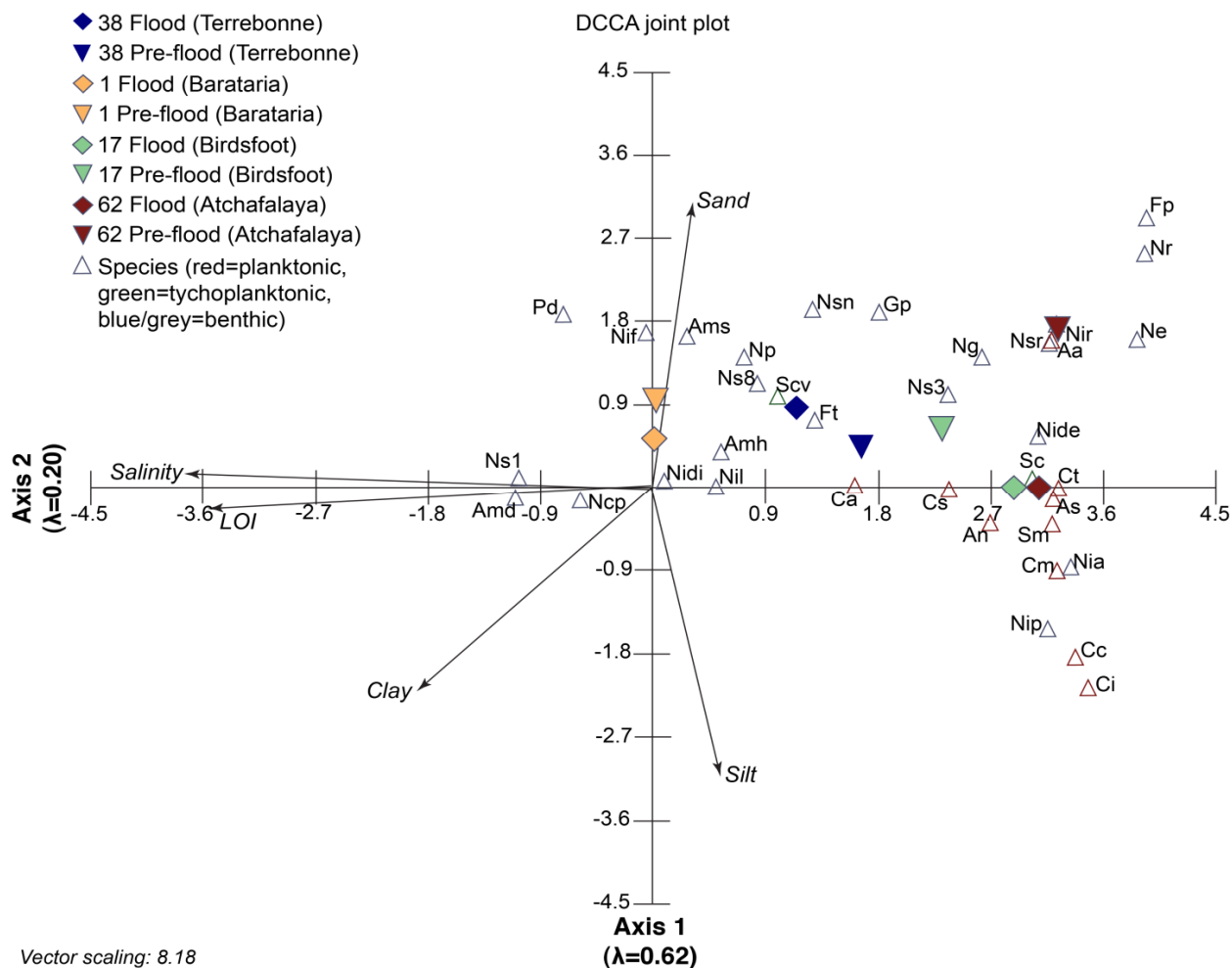


Figure DR6. Joint ordinations diagram for sampling sites (flood (diamonds) and pre-flood (downward-facing triangles)) and species occurring at greater than 2% within sample (triangles) based on Detrended Canonical Correspondence Analysis (DCCA) of diatom counts from Louisiana deltaic wetlands. Five environmental variables (salinity, LOI, sand, silt and clay fractions) are shown by arrows. Species codes: Aa – *Aulacoseira ambigua*; An – *Actinocyclus normanii*; As – *Aulacoseira subborealis*; Amd – *Amphora delicatissima*; Amh – *Amphora holsatica*; Ams – *Amphora* spp.; Ca – *Cyclotella atomus*; Cc – *Cyclotella cryptica*; Ci – *Cyclostephanos invisitatus*; Cm – *Cyclotella meneghiniana*; Cs – *Cyclostephanos* spp.; Ct – *Cyclostephanos tholiformis*; Fp – *Fallacia pygmaea*; Ft – *Fallacia tenera*; Gp – *Gyrosigma peisonis*; Ncp – *Navicula cf. platyventris*; Ne – *Navicula erifuga*; Ng – *Navicula gregaria*; Np – *Navicula perminuta*; Nr – *Navicula rostellata*; Nsn – *Navicula salinicola*; Nsr – *Navicula salinarum*; Ns1 – *Navicula* sp. 1; Ns3 – *Navicula* sp. 3; Ns8 – *Navicula* sp. 8; Nia – *Nitzschia archibaldii*; Nide – *Nitzschia debilis*; Nidi – *Nitzschia dissipata*; Nif – *Nitzschia frustulum*; Nil – *Nitzschia liebtruthii*; Nip – *Nitzschia palea*; Nir – *Nitzschia rosenstockii*; Pd – *Planothidium delicatulum*; Sc – *Staurosira construens*; Scv – *Staurosira construens* var. *venter*; Sm – *Stephanodiscus minutulus*