A quantitative analysis of the organic and mineral content of Mississippi River suspended sediment in the falling hydrograph

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Introduction: The Mississippi River (MR) is a critical source of sediment particles to its neighboring wetlands and is the focus of ongoing research in Louisiana as a means of delivering sediment through river diversions for coastal restoration efforts. Much of what is considered mineral sediment available for delivery to wetlands by the MR is really allochtonous organic matter (OM), but this distinction is not often made due to limited sampling to date of the detailed organic characteristics of suspended sediment. This study focuses on the falling-to-low discharge period on the MR hydrograph, when suspended sediment concentrations (SSC) are typically relatively low due to basin hysteresis; however, peaks in turbidity, a proxy for SSC, during past low discharge events in June-August suggest the presence of an unconstrained sediment source. The goal of this analysis is to determine the relative importance and composition of biogenic material of the suspended sediment to address the hypothesis that, as sediment delivery from the catchment falls, the river "greens" with phytoplankton in response to the reduction in turbidity. Thus, we hypothesize that there are three phases of sedimentary particles carried by the Mississippi River available to river diversions—mineral, old (soil and woody) OM bound with the mineral particles, and fresh phytoplankton OM particles, and that these sources co-vary on daily and seasonal timescales linked to the river's hydrograph.

Objective: to quantify the sediment (mineral) and organic (biogenic) proportions and characteristics of suspended sediment in the lowermost MR at New Orleans (Fig. 1) extending from the early summer period of high discharge through to low discharge in late fall and winter.

Purpose: to constrain the changing mineral and biogenic components in the river that might be discharged by a sediment diversion to:

1. Determine its land-building capability.
2. Assess any possible influence on the ecology of the estuarine receiving basin.

Figure 1

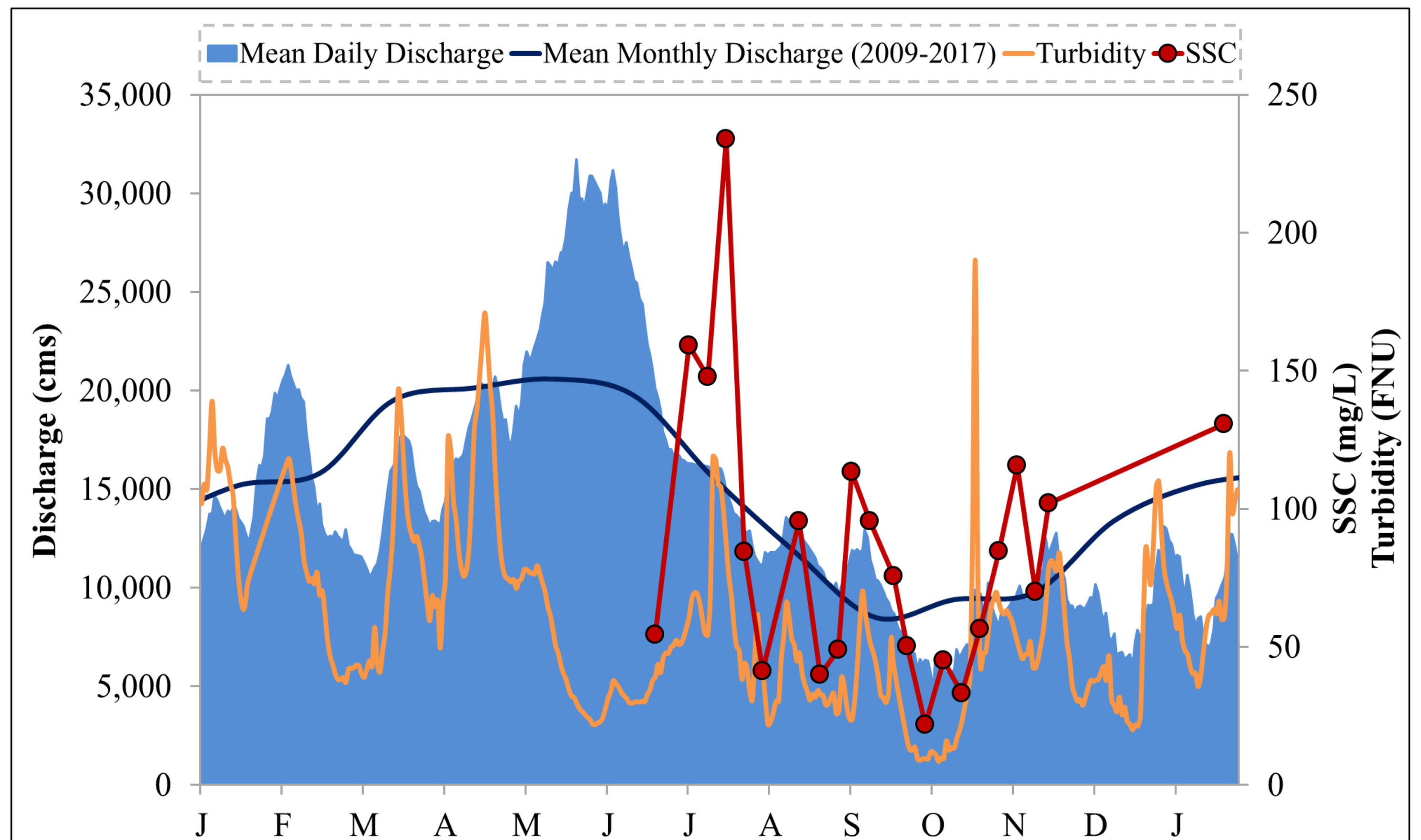

Figure 2

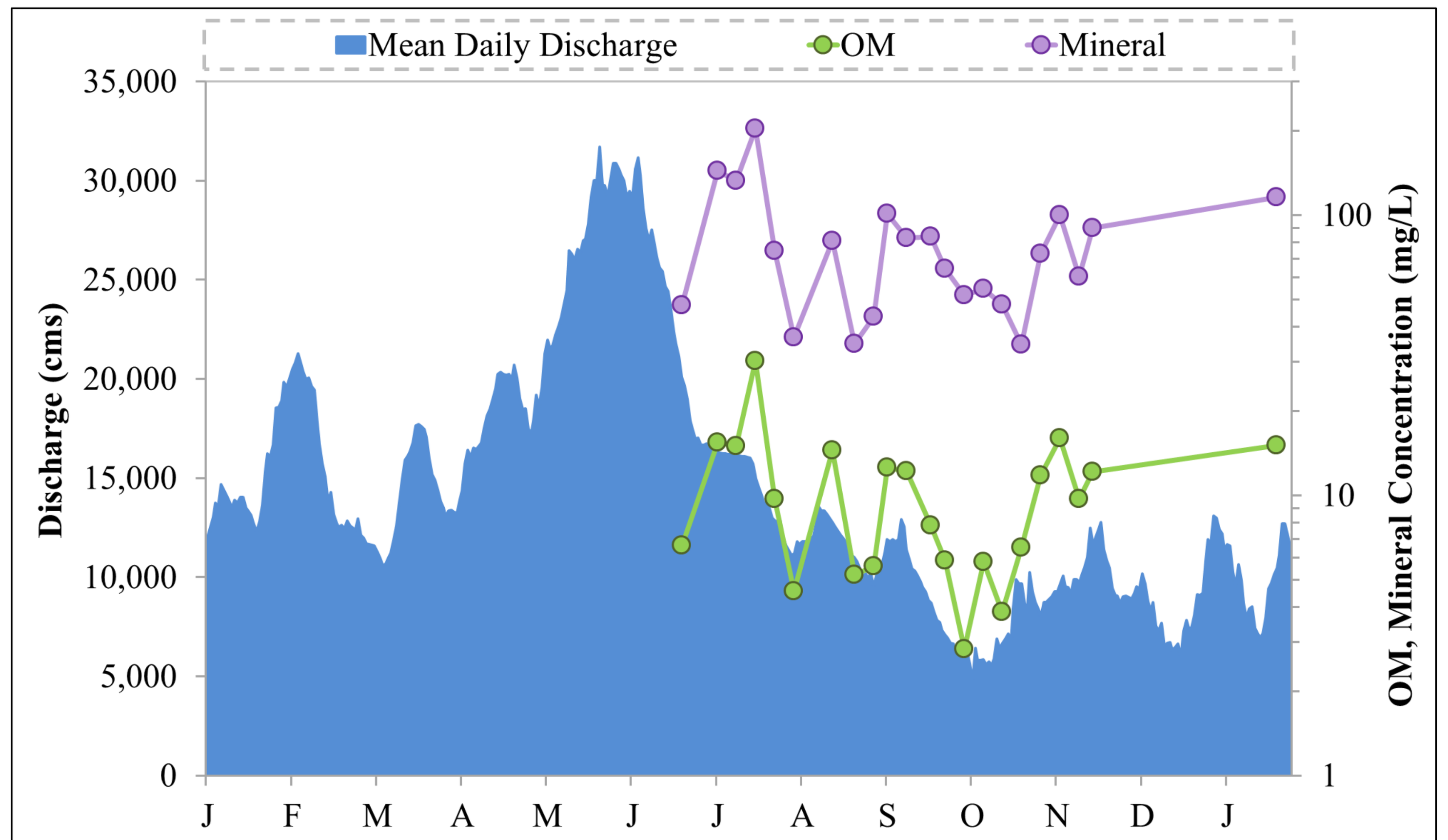

Figure 3

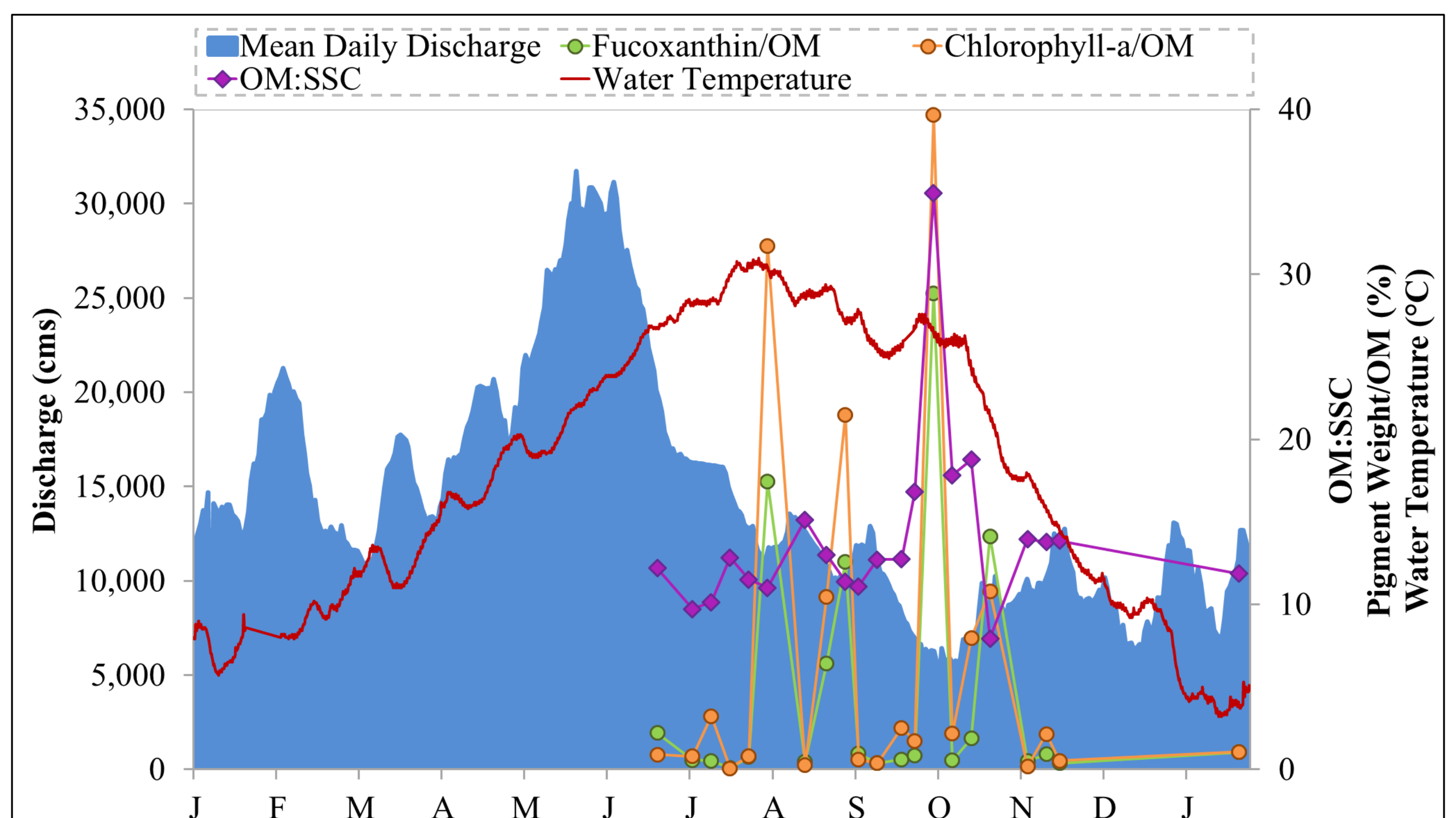

Figure 4

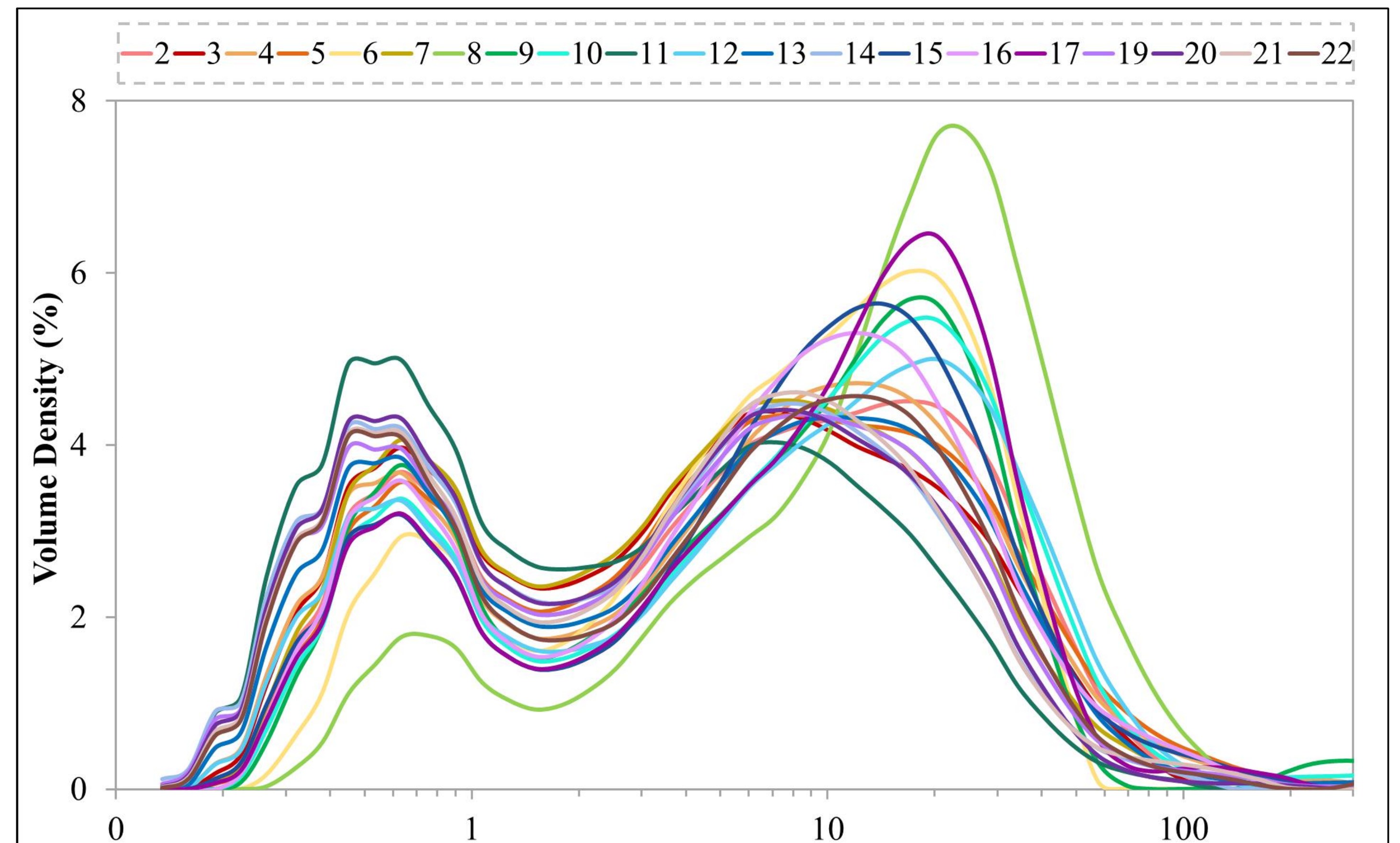

Figure 5

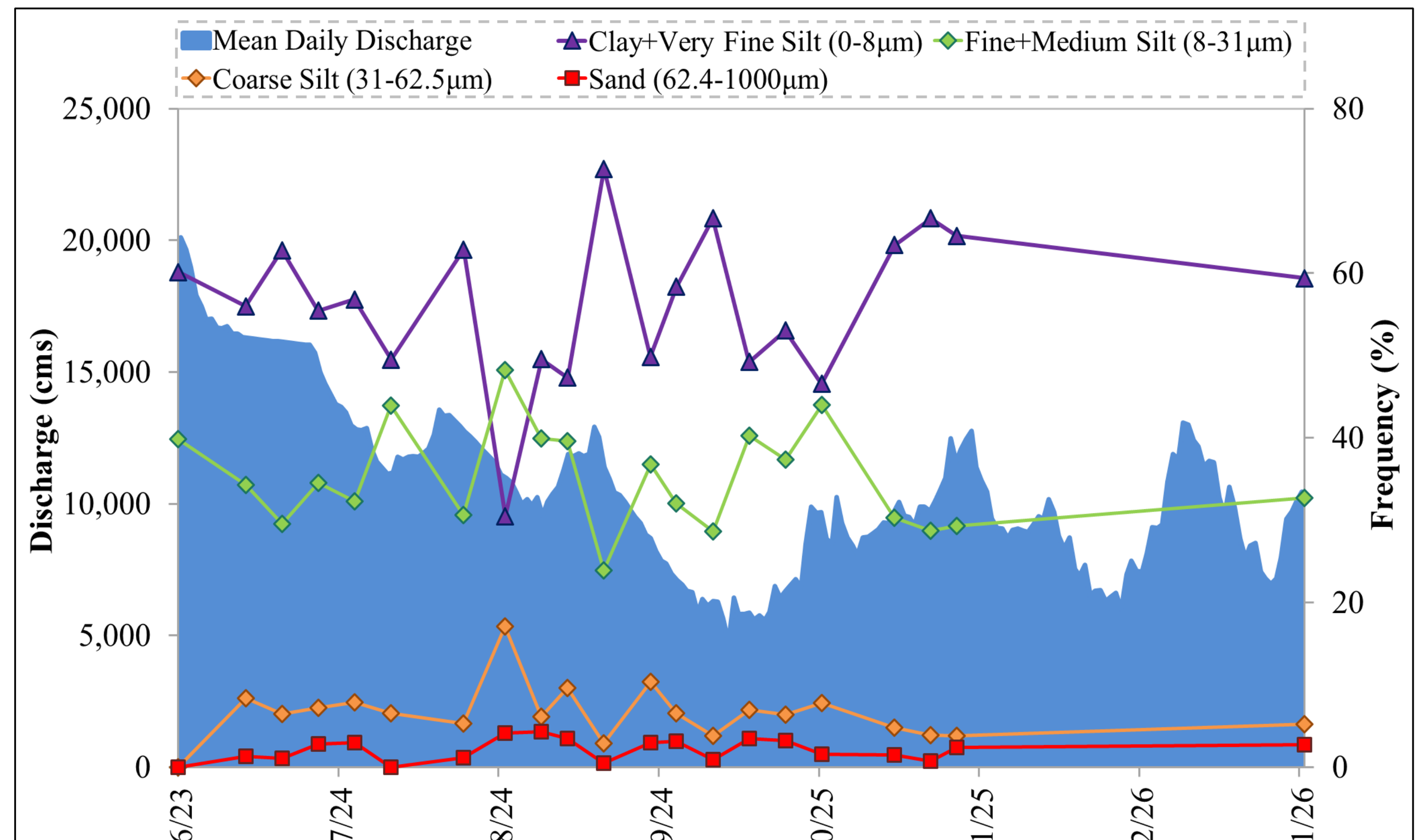

Figure 6

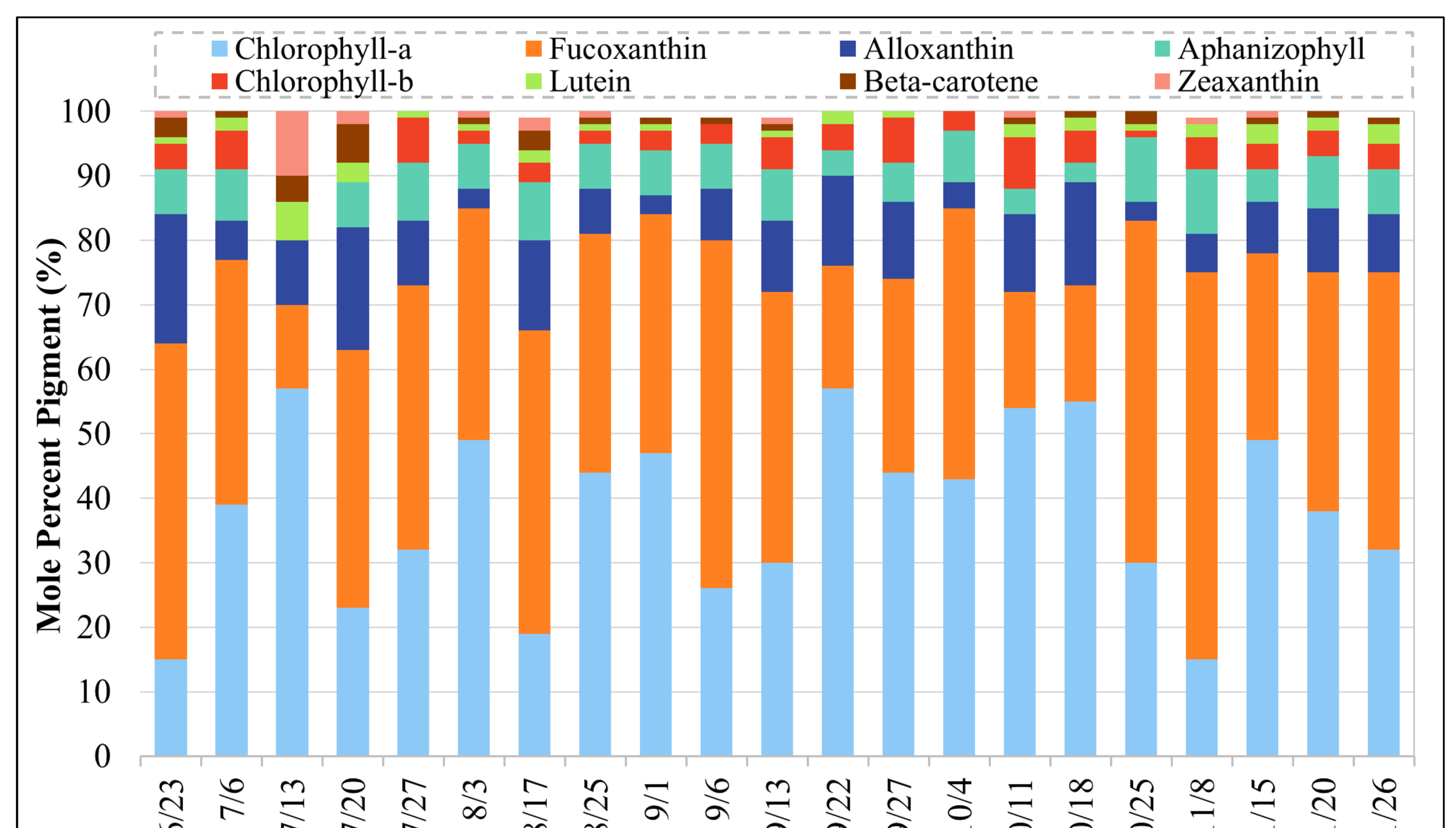

Figure 7

Methods

- *Water sample collection*
  - **What:** (1) a large inorganic (2-6 L) water sample (stored in the dark at room temperature) and (2) a small organic sample (stored frozen on GF/F)
  - **When**: Weekly collection from June – late November 2017 with an additional sample collected in January to allow the data set to extend to the first hydrograph peak of the new water year
  - **Where**: Port of New Orleans Plaza (adjacent to Tulane River and Coastal Center)
  - **How:** An electric pumping system with an attached weight to collect samples at ~2m deep
- *Laboratory analyses (TU)*
  - Filtered large inorganic sample → SSC (Fig. 2)
  - Ashed sediment (LOI) → organic matter and mineral fractions, corrected to SSC to get OM and mineral concentrations (Fig. 3)
  - Sonicated ashed samples in sodium metaphosphate solution and used laser diffraction analyzer → grain size information (Fig. 5, 6)
- *Laboratory analyses (UF)*
  - Prepared small organic sample for pigment extraction via freeze drier, probe sonication, and acetone rinse
  - Executed UPLC analysis → relative abundance of pigments and carotenoids (Fig. 7) and pigment weight relative to OM (Fig. 4).

Key Findings

1. SSC decreases coincident with falling discharge, supporting that SSC is directly related to the water discharge hydrograph. SSC and turbidity trends also correspond, although not all turbidity spikes are reflected in the SSC dataset (Fig. 2).
2. Most suspended material in the falling-to-low discharge period is mineral (μ = 79.85 mg/L) with concentrations relatively invariant (σ = +/-40.45). Mineral and OM concentrations co-vary, suggesting that OM is mostly bound to mineral aggregates as opposed to individual biogenic particles (i.e., diatoms; Fig. 3).
3. Pigment abundance spikes during the lowest observed discharge periods coincident with relatively high water temperatures. OM:SSC also increases sharply during the lowest discharge event, suggesting river greening and high diatom abundance. Background OM:SSC values of 10-15 reflect OM from degraded soil carbon bound to mineral particles (Fig. 4).
4. Fucoxanthin and chlorophyll-a are the dominant pigments in the lowermost MR during low discharge. Their relative abundances remain relatively constant over the study period (Fig. 7) but spike to their highest levels in the OM concentration during the low discharge greening event.
5. Clay and very fine mineral silt are the dominant (disaggregated) grain size modes during low flows with fine and medium silts making up the second most significant mode (Fig. 6, 7). Grain size makeup is relatively invariant, although coarsening coincides with pigment spikes (Fig. 4) and fining corresponds with falling discharge. The fine grain size of the mineral sediment also supports the possibility of freshwater particle aggregates.

Literature cited

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