

Carbon and nitrogen stable isotope composition of OM from Florida Bay, initial results of a paleoenvironmental seagrass reconstruction

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1. Introduction

The shallow marine waters of Florida Bay represent an ideal environment for seagrasses, which are the most common benthic community in the region. However, seagrass communities are susceptible to a variety of anthropogenic disturbances, particularly changes in water quality, and environmental conditions in Florida Bay have become a concern due to recent increases in salinity, algal bloom frequency, and seagrass mortality. These changes have been attributed to 20th century decreases in freshwater discharge from the Everglades to Florida Bay, deteriorated water quality, and changes in exchange between Florida Bay and the Atlantic Ocean. In order to better understand environmental change over long time scales, sediment cores were collected in Summer 2002 from 4 locations in Florida Bay for multiple proxy analyses of seagrass abundance. Here we present bulk carbon and nitrogen stable isotope data with sediment nutrient data from 2 sites, Bob Allen Bank and Trout Creek (FIG. 1).

The carbon and nitrogen isotopic composition of sedimentary organic matter has been used to trace changes in source and composition of preserved organic material. Terrestrial $\delta^{15}\text{N}$ signatures tend to be low (0 to 4‰) due to abundant soil microbial N_2 -fixation, whereas marine and estuarine sources show more highly fractionated $\delta^{15}\text{N}$ signatures due to recycling of N-compounds in the system. Terrestrial $\delta^{13}\text{C}$ signatures are generally depleted (-26 to -30‰) due to isotopic discrimination under atmospheric CO_2 -saturation; marine signatures tend to be more enriched due to the more limited supply of dissolved C. Further, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures may also reflect changes in nutrient availability and primary production in marine environments. This is because aquatic plants discriminate against ^{13}C and ^{15}N in the available nutrient pools, preferentially removing ^{12}C and ^{14}N during uptake. As C and N become depleted, discrimination decreases and the isotopically enriched residual pool is incorporated in sedimentary organic matter. Finally, C:N:P ratios of preserved organic matter complete the productivity picture, illustrating changing nutrient limitation over time.

3. Methods

- Piston cores were collected, subsampled at 2 cm increments, dried at 70°C, powdered with mortar & pestle, and homogenized.
- %TIC, %TOC, and C:N:P ratios analyzed following standard EA methods.
- Bulk organic matter $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analyzed using standard EA-IRMS methods. All values are reported as δ -values and are in units of ‰ (air) for ^{15}N and ‰ (PDB) for ^{13}C . (Finnigan MAT Delta C).
- Age constraints:
 - ? ^{210}Pb activity: upper 50 cm of each core.
 - ? ^{14}C -ages: peat deposits, Bob Allen Bank core.

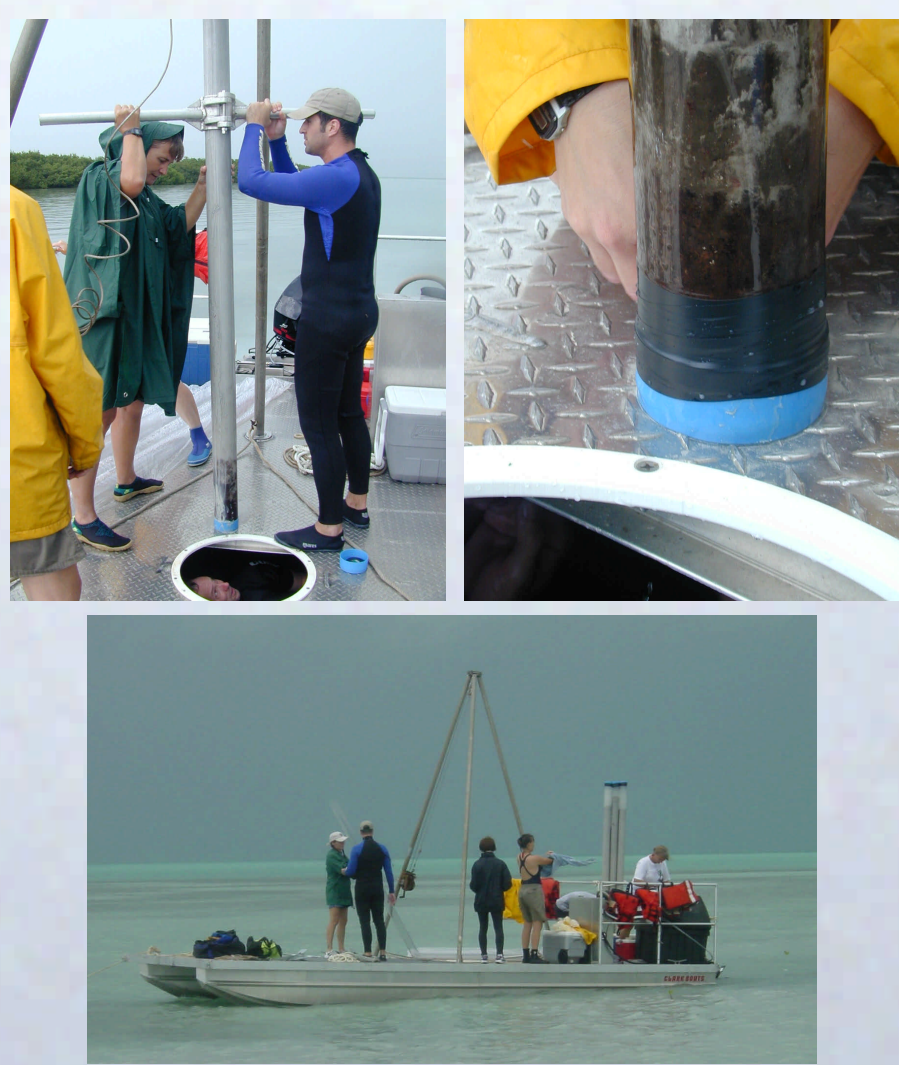
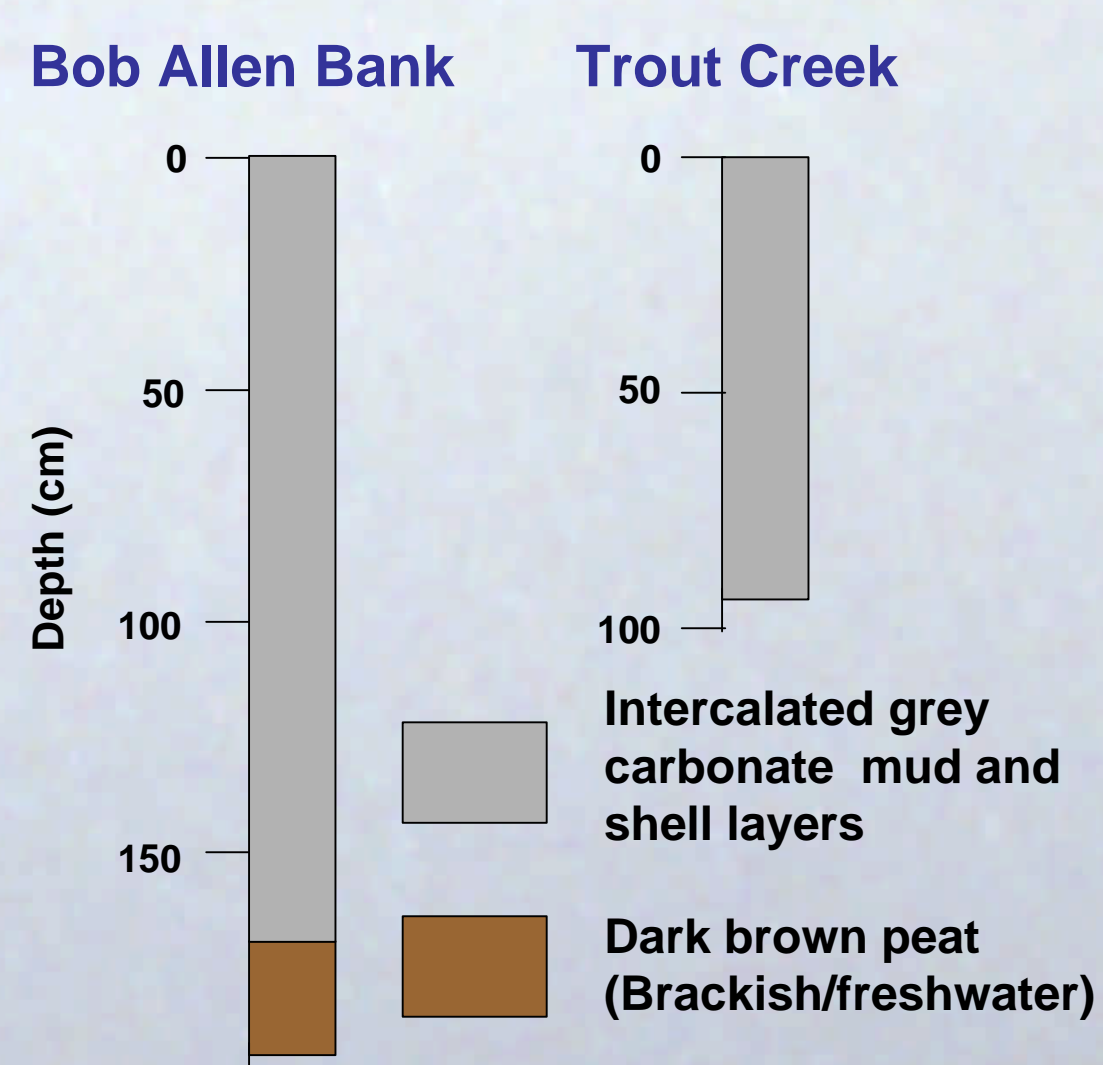
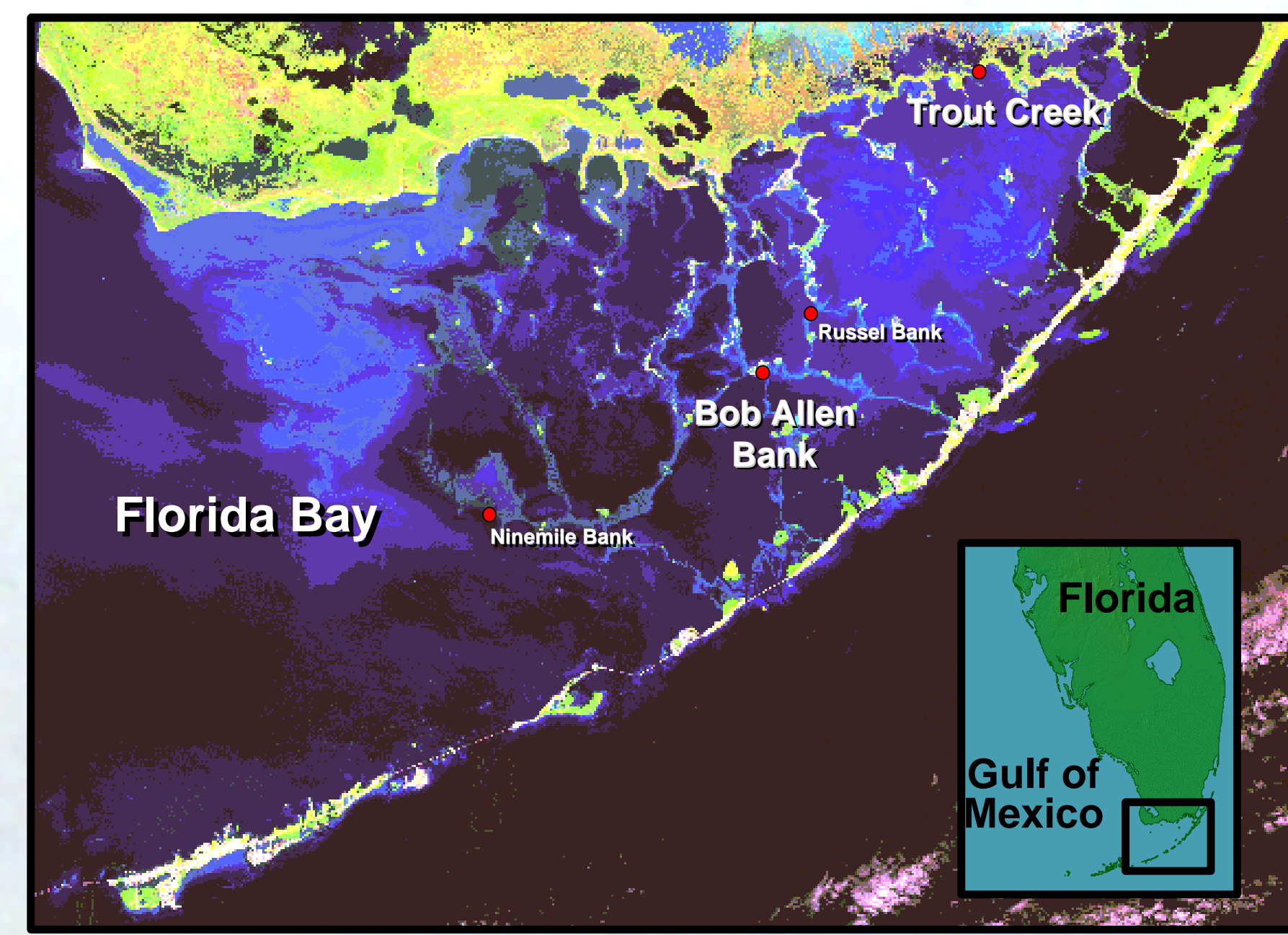


FIG. 2 Piston coring from USGS pontoon barge

4.1 Results - Stratigraphy



2. Study Area – Florida Bay core collection sites



* Data from Ninemile Bank and Russel Bank pending

FIG. 1 Cores were collected from the accreting side (SW) of 4 carbonate banks in Florida Bay. Previous coring by Holmes et al. (2001) demonstrated that these sites have sediment accumulation rates and preservation conditions allowing recovery of undisturbed cores. Here we present stable isotope and nutrient stratigraphy for 2 of the sites, Bob Allen Bank and Trout Creek, which are estimated to have sediment accumulation rates of 0.5 ± 0.05 and 0.3 ± 0.05 cm yr⁻¹, respectively.

4.3 Results - Paleoenvironmental

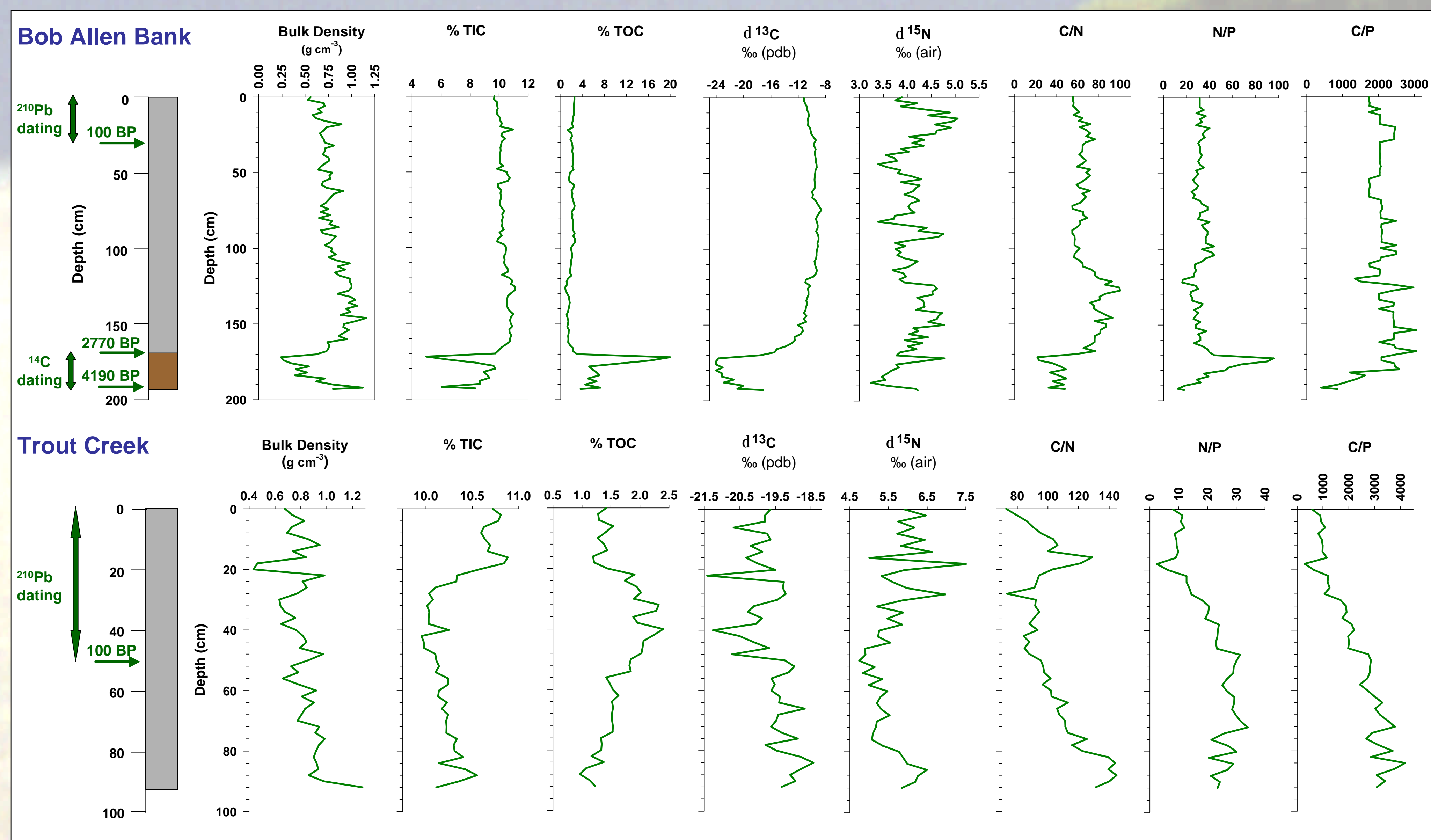


FIG. 5 Displays all data collected from the Bob Allen Bank and Trout Creek cores:

- Bulk density in both cores reflects changes in sediment composition between fine grained carbonate muds, loosely packed shell fragment layers, and peat. Gradual density increases with depth in the cores imply sediment compaction.
- %TIC and %TOC plots demonstrate changes in organic content. The transition from carbonate mud to basal brackish-freshwater peat is the dominant feature in the Bob Allen Bank core. Peaks in Trout Creek %TIC indicate the position of shell layers.
- Carbon and nitrogen isotope stratigraphy show differences in organic matter source between marine seagrass and terrestrial mangrove signatures. In conjunction with C:N:P ratios, variations in isotope values also show changes in nutrient limitation and productivity.

4.4 Results – Productivity & Nutrient Limitation

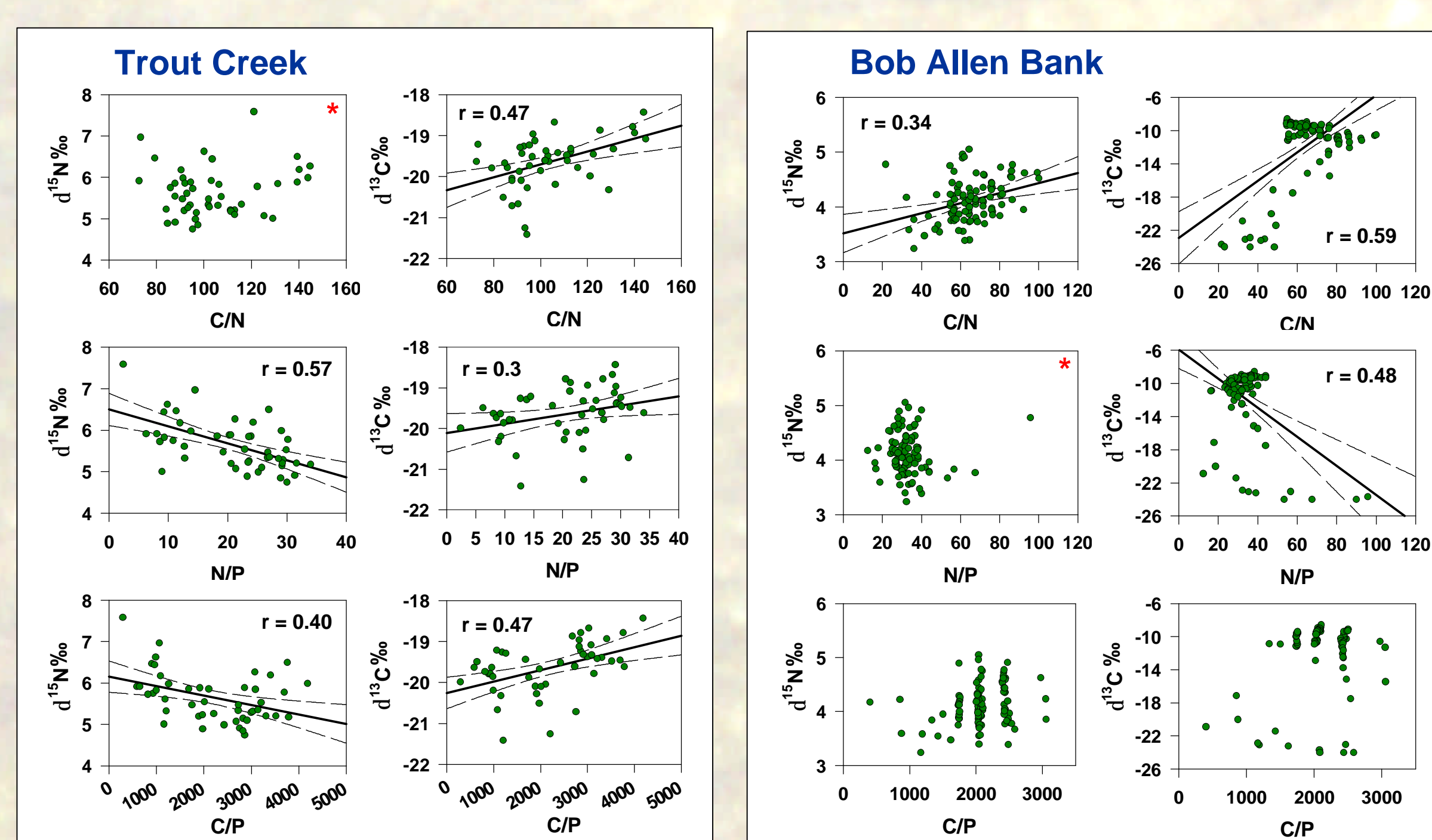


FIG. 6 Shows isotopic signatures and nutrient ratios in the cores from each site. Regressions and 95% confidence intervals are shown where $r = 0.3$. Except when otherwise indicated, all correlations are at the $p < 0.05$ significance level.

- As C/N ratios increase, both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are enriched. This implies limitation in both nutrients. Increases in productivity could deplete available C and N leading to decreases in isotopic discrimination.
- At Trout Creek, increasing N/P and C/P ratios correspond to $\delta^{13}\text{C}$ enrichment and $\delta^{15}\text{N}$ depletion. Interior Florida Bay is considered P-limited, so increasing N/P suggests increasing N-availability. Isotopic discrimination results in depleted $\delta^{15}\text{N}$ values. Increasing C/P ratios imply high productivity and organic carbon burial, and decreases in ^{13}C -discrimination would be expected.
- At Bob Allen Bank, relationships between isotopic signatures and nutrient ratios are skewed by the presence of the peat layer with the depleted terrestrial $\delta^{13}\text{C}$ signal.

5. Conclusions and future work

- $\delta^{13}\text{C}$ signatures indicate that a stable seagrass community has existed in central Florida Bay throughout the period of carbonate mud deposition.
- Sedimentary organic matter preserved proximal to terrestrial inputs have isotopic signatures indicative of mixing of marine and terrestrial signals over time.
- Enrichment patterns of $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ reflect increases in productivity and nutrient limitation.
- Patterns of $\delta^{15}\text{N}$ depletion may indicate periods of higher N-availability.
- N/P and C/P ratios over time indicate that Florida Bay has been P-limited in the past as it is today.
- Further work will include geochemical analyses of cores from a total of 4 sites in replicate. In addition, foraminifera and diatom assemblages, organic biomarkers, and compound-specific stable isotopes will be analyzed. Gaps in chronology will be filled with ^{14}C -dates on shell material.

* $p > 0.05$

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