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An assessment of Blue Carbon sources and potential in the Nisqually Estuary using biomarkers and compound-specific isotopes of marsh plants, eelgrass, and sediment

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BACKGROUND

Coastal Blue Carbon ecosystems (e.g., marshes, seagrasses, kelp) sit at the land-sea interface and thus receive organic carbon (C_{org}) inputs from adjacent ecosystems. Differentiating between in situ versus transported C_{org} sources is fundamental to avoiding duplication in Coastal Blue Carbon accounting.

STUDY GOALS

Develop a suite of distinctive geochemical tracers, or signatures, that can differentiate among various C_{org} sources to advance Blue Carbon budgets.

APPROACH

Tidal flow restoration in the Nisqually River Delta is altering land to sea fluxes of terrestrial, marsh, and marine C_{org} and sediment. Plant end members were characterized to develop multivariate C_{org} source signatures, which were then applied in a nearshore sediment core to determine C_{org} sourcing over time.

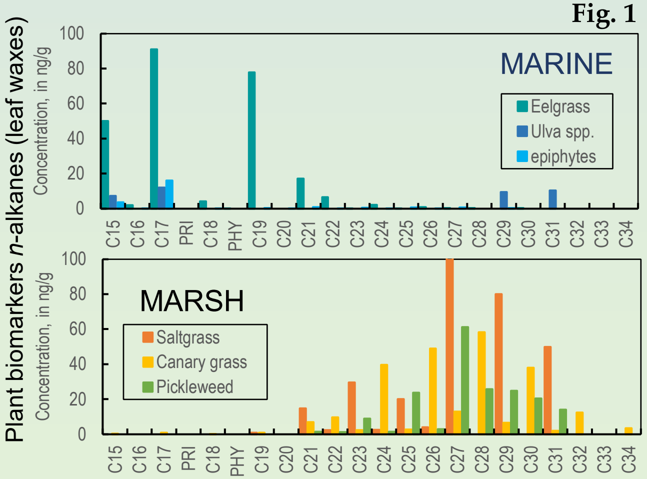


Fig. 1

RESULTS – BIOMARKERS and ISOTOPES

C_{org} from marine and marsh plants had **distinct *n*-alkane** distributions **(Fig. 1)**, C:N ratios, $\delta^{13}C_{n\text{-alk}}$, $\delta^{15}N$ ratios, and distinct $\delta^{13}C$ ratios except for salt grass, which had a marine-like $\delta^{13}C$ ratio **(Fig. 2)**. **Sterols did not** distinguish between marine and terrestrial C_{org} sources (not shown).

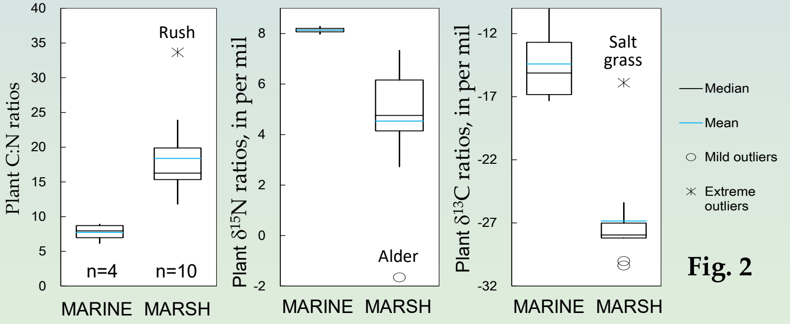


Fig. 2

PRINCIPAL COMPONENT ANALYSIS (PCA)

Multivariate C_{org} source signatures were determined by PCA on log-transformed C:N ratios, $\delta^{15}N$, and select *n*-alkanes (C_{19}, C_{27}, C_{29}, C_{30}) in marine and marsh plants. The same variables were used to reconstruct C_{org} sourcing by PCA in marsh sediment (LES, SHA, FW) and the sediment record of a nearby eelgrass bed. $\delta^{13}C$ data is skewed and cannot be used as a variable. PCA was performed using the 'prcomp' function in R software.

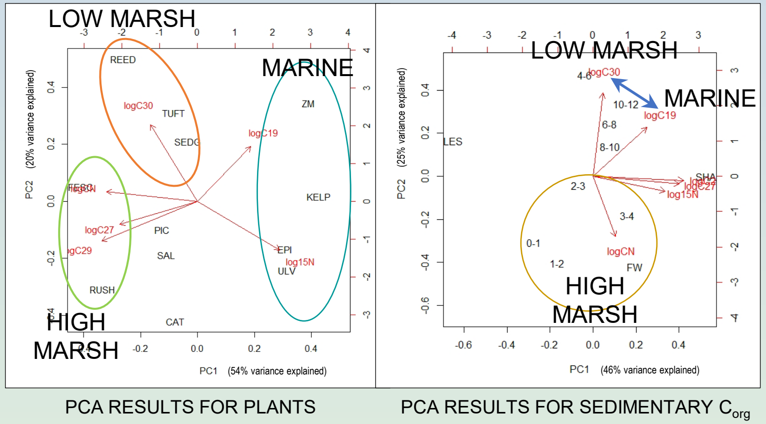
ANALYTICAL METHODS – Plant biomarker (*n*-alkanes, sterols) extraction and analysis methods are available upon request. Methods for bulk $\delta^{13}C$, $\delta^{15}N$, and C:N ratios in plant and sediment are available from UC Santa Cruz at https://sites.google.com/ucsc.edu/sil; and from UC Davis for CSIA $\delta^{13}C_{n\text{-alk}}$, $\delta^{13}C_{sterol}$ at http://stableisotopefacility.ucdavis.edu.

PCA RESULTS – PLANTS

C_{org} sources were characterized by **(Fig. 3)**:

- Marine plants: $\delta^{15}N$, C_{19} *n*-alkane
- Low marsh plants: C_{30} *n*-alkane
- High marsh: C:N ratio, C_{27}, C_{29} *n*-alkanes
- Pickleweed, salt grass, and cattail were poorly characterized by this PCA because no variables plotted in their vicinity.

Fig. 3



PCA RESULTS FOR PLANTS PCA RESULTS FOR SEDIMENTARY C_{org}

PCA RESULTS – SEDIMENTS

Two principal components (PCs) explained 71% of the geochemical variance. PC1 describes estuarine sediment with terrestrial C_{org} (LES, SHA). PC2 describes nearshore sediment with high marsh C_{org} in the upper 0-4 cm, and mixed low marsh/marine C_{org} in deeper sediment (4-12 cm) that is stabilized by the presence of eelgrass roots and rhizomes.

SIGNIFICANCE for BLUE CARBON, RESTORATION

- The restoring Nisqually Estuary affects Coastal Blue Carbon budgets because deeper buried C_{org} is from marine and low marsh plants with lower C:N ratios and lower Blue Carbon potential.
- C_{org} delivery to nearshore sediments has transitioned to more terrestrial sources (high marsh, not 'blue' carbon) as restoration progresses.