Sea Level Rise Alters Salt Marshes' Carbon Storage Capacity

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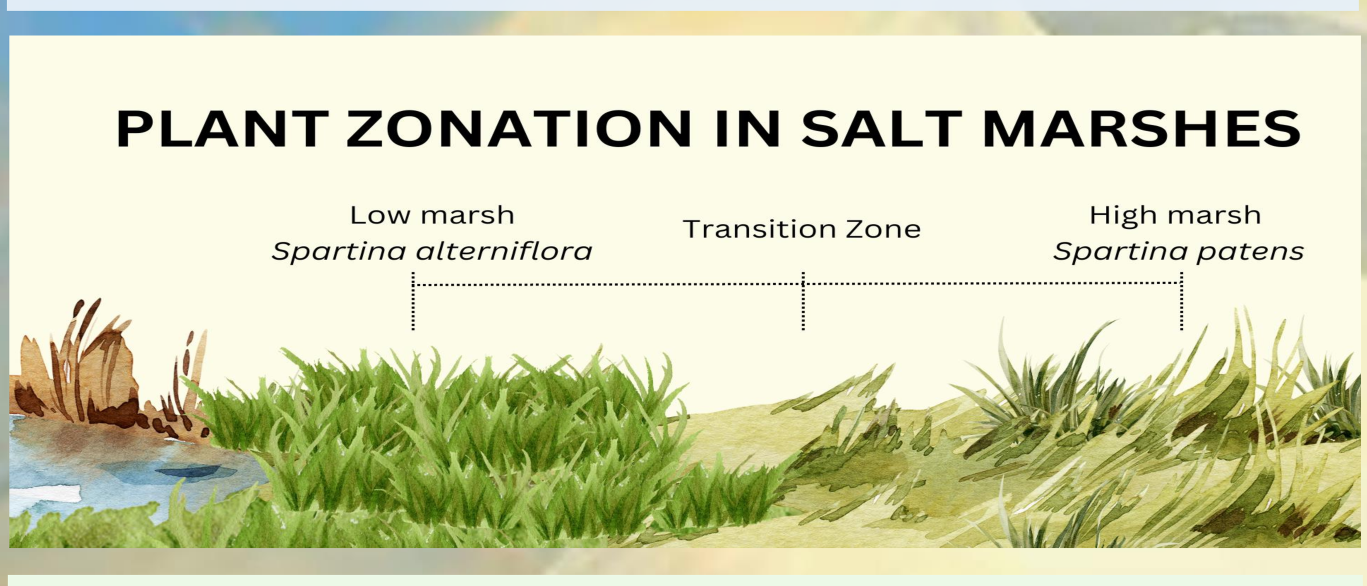
BACKGROUND

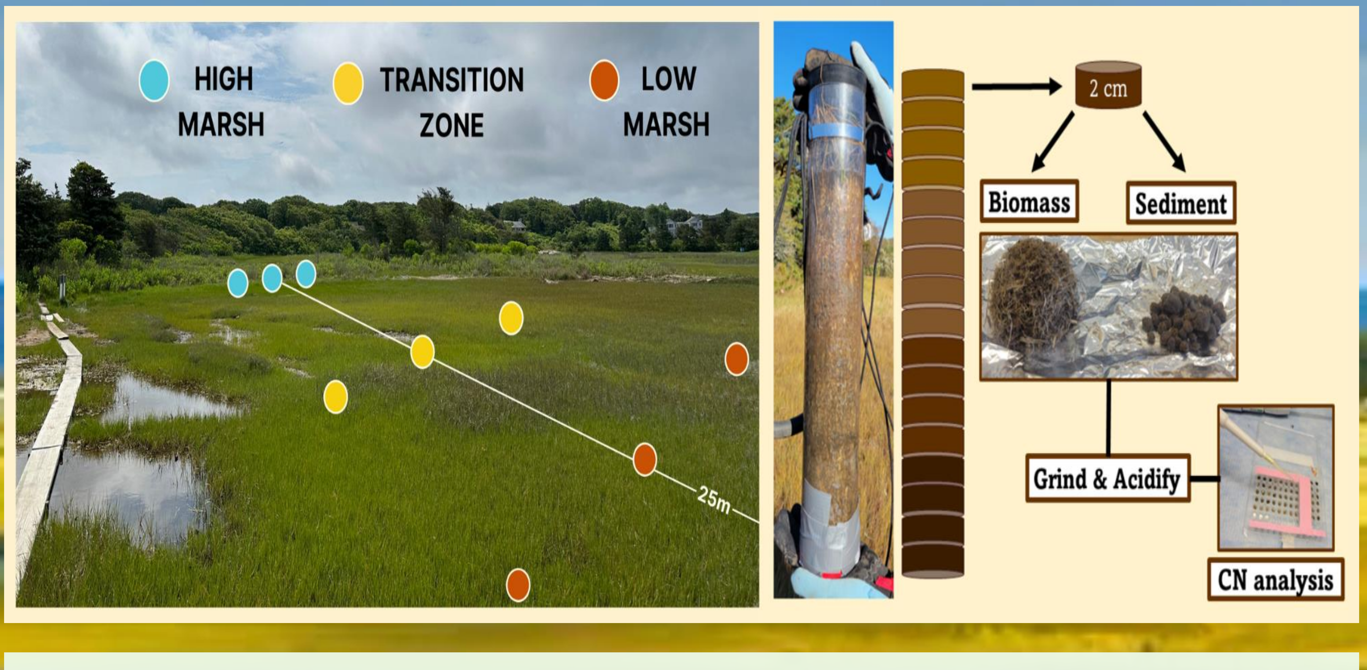
Accelerating sea level rise threatens coastal salt marshes, which provide essential ecosystem services, including long-term carbon sequestration. Salt marshes sequester carbon through biomass production and long-term burial in anoxic, waterlogged soils. The Great Sippewissett Marsh (Falmouth, MA), an ecosystem with decades of ecological monitoring, is undergoing vegetation shifts driven by rising sea level. As *Spartina alterniflora,* a salt-tolerant low marsh species, migrates inland, it increasingly colonizes transition zones; areas once dominated by high marsh plants like *Spartina patens*. This research examines how vegetation shifts alter marsh carbon storage, particularly the balance between short-lived biomass and long-term sediment burial.



Salt marshes have distinct vegetation zones based on salinity and flooding. *Spartina alterniflora* dominates low marsh, while *Spartina patens* covers the high marsh. With rising sea levels, the low marsh is expanding into declining high marsh areas, creating a transition zone.

How does vegetation zonation, shaped by sea level rise, affect the capacity of salt marshes to sequester carbon in stable sediment pools?

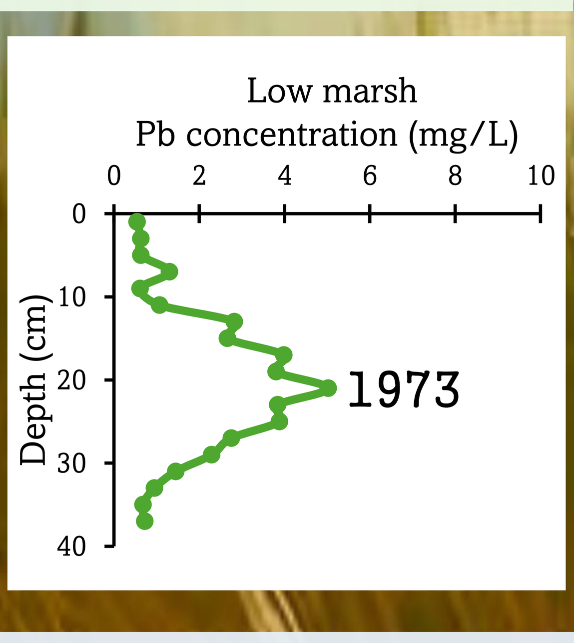
METHODS



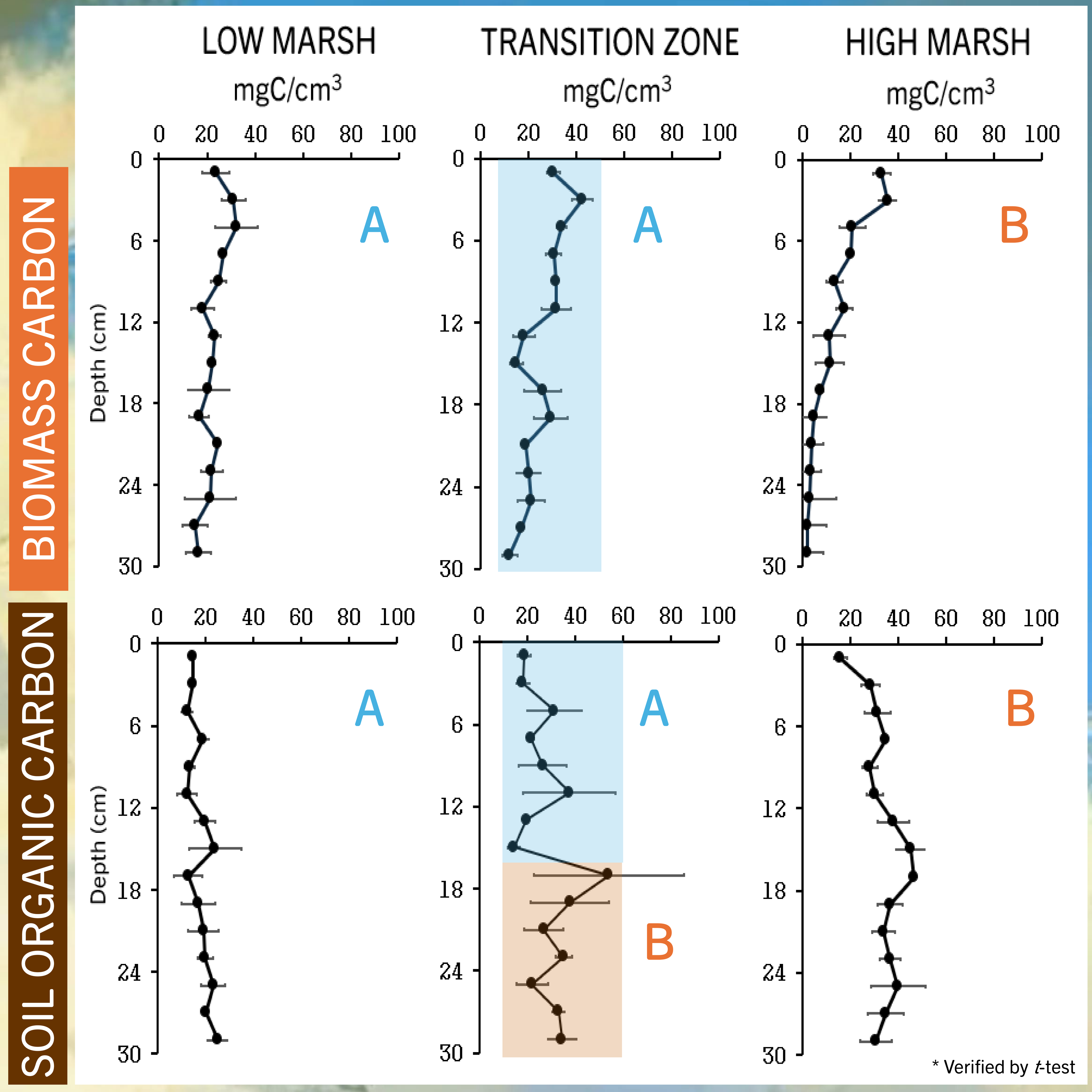
Field Design (left) and Methods (right)

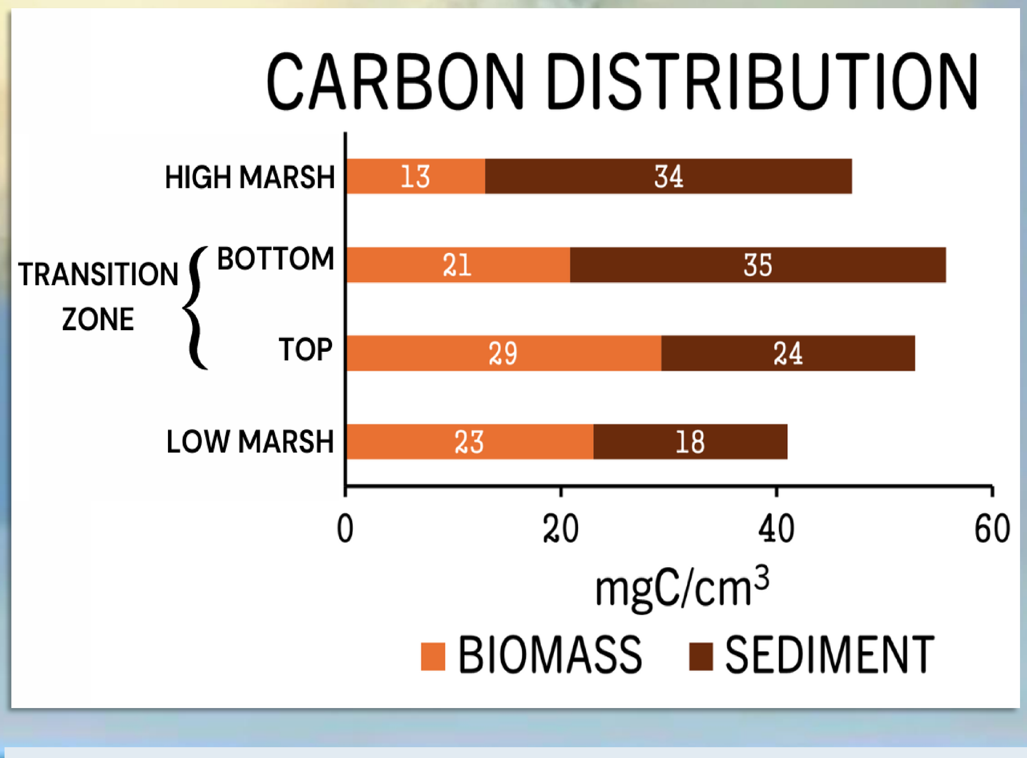
- Divided transect into three zones: low marsh, transition zone, and high marsh Collected three sediment cores per zone (9 total).
- Sectioned at 2 cm intervals to a depth of 30 cm.
- Separated samples into belowground biomass (roots and rhizomes) and sediment (soil carbon).
- Measured carbon content (%) with an elemental analyzer and used lead (Pb) analysis to estimate sediment accretion rates and calculate carbon burial.

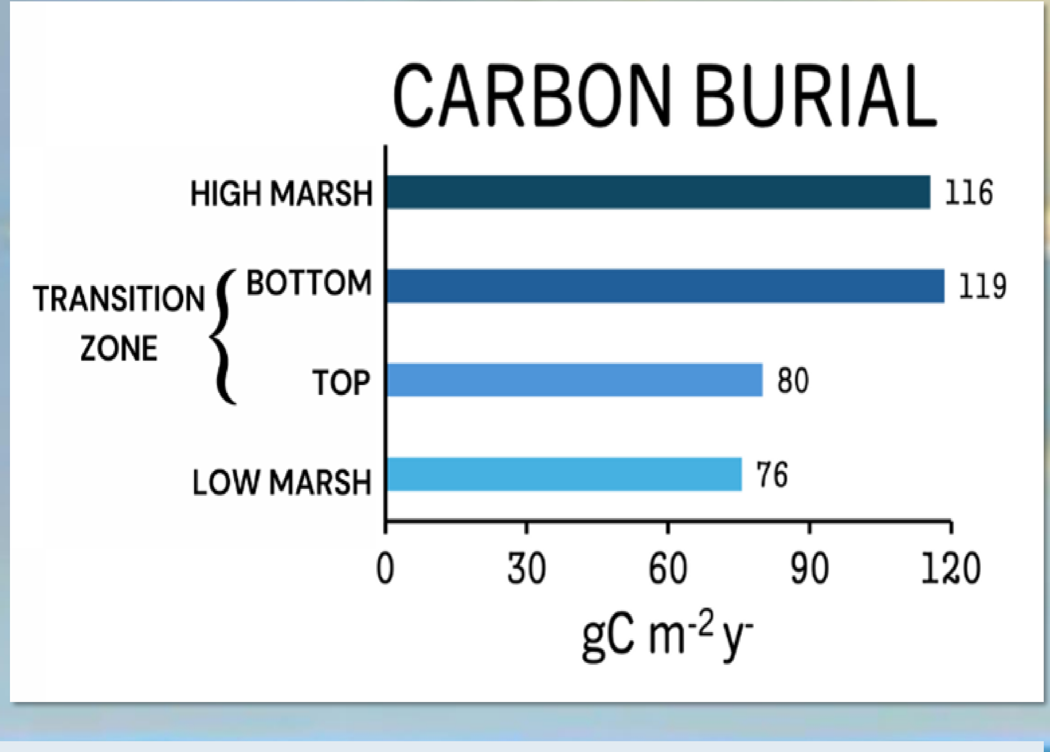
Sediment accretion rates were estimated from distinct Lead (Pb) peaks, anchored to 1973, a benchmark year marking reduced leaded gasoline use in the U.S. These rates inform burial potential across marsh zones.



RESULTS







- **Belowground biomass carbon** declines with depth in the high marsh but remained consistent in the low marsh, reflecting deeper root penetration by *Spartina alterniflora*. The transition zone mirrored the low marsh profile, suggesting full vegetation and root structure conversion.
- **Soil Organic Carbon content** was nearly twice as high in the high marsh compared to the low marsh. In the transition zone, deeper soils retain the carbon storage signature of legacy high marsh, while the surface sediments reflect the lower carbon content characterizing the low marsh.
- **Carbon distribution** shifts from sediment dominance in the high marsh to biomass dominant in the low marsh.
- **Carbon burial capacity** was greatest in the high marsh with significant declines across the transition and low marsh zones.

CONCLUSIONS

As sea level rises and low marsh vegetation expands, carbon storage shifts from sediment-dominated to biomass-dominated pools. Even in historically resilient marshes, this transition reduces long-term sequestration by redirecting carbon into less persistent biomass, especially in zones colonized by *Spartina alterniflora*.

Our findings highlight that species identity and sediment dynamics shape the fate of carbon in salt marshes. Accurately forecasting future carbon storage requires a better understanding of how vegetation shifts influence burial processes and belowground carbon persistence.

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