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Middle to Late Holocene fluctuations of C3 and C4 plant communities and carbon sequestration in a Northern New England salt marsh, Maine, USA

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A 3.1 meter sediment core was analyzed for stable carbon isotope composition of organic matter and higher plant leaf wax (HPLW) lipid biomarkers and AMS radiocarbon dated to determine Holocene shifts in C3 (higher high marsh) and C4 (low and/or high marsh) plant deposition at the Sprague River Salt Marsh, Phippsburg, Maine.

The HPLW isotope data are consistently depleted in 13C by ˜7L' relative to the bulk isotope data and are correlated strongly to each other, where 13CHPLW = 0.9 13Cbulk - 7.5 (R2 = 0.90). The consistency in isotopic offset between the HPLW and the bulk sediments suggests that terrestrial plants were an important source of organic matter to the sediments, and diagenetic alteration of the bulk sediments was minimal. Between 3700 and 2500 cal yr BP, tidal flat muds and sands containing sporadic shell and wood fragments are preserved at the site. These tidal flat sediments have relatively high C/N values and depleted 13CHPLW values suggesting that C3 terrestrial plant matter was a significant source or organic detritus in the intertidal zone in the middle to late Holocene.

At 2500 cal yr BP, the current salt marsh was established. Isotopic data indicate that low and/or high C4 marsh plants dominated deposition at 2000 cal yr BP, 700 cal yr BP, and for the last 200 cal yr BP. Expansion of higher high marsh C3 plants occurred at 1300 and 600 cal yr BP. The isotope data suggest that the salt marsh plant communicates have responded to small changes in relative local sea level (i.e., two transgressional-regressional sequences followed by a transgressional sequence) over

the last 2500 years. These shifts represent changes in the balance between RSLR and sediment accumulation.

Average annual carbon sequestration rates for the last 2500 years approximate 40 g C yr-1 m-2, and are in strong agreement with other values published for the Gulf of Maine. Given that Maine salt marshes cover an area of ˜79 km2, their importance as a carbon sink should not be overlooked. It has been argued by some that a continued rise in sea level brought about by global warming would actually increase the terrestrial carbon sink by expanding salt marshes onto gently sloping upland terrain, thus modulating future global warming and sea level rise. However, Sprague Marsh, and many others in the south-central region of the Gulf of Maine, occupy glacially carved valleys and are surrounded by topographic highs. A rapid sea level rise in the Gulf of Maine might result in drowning of the salt marshes and loss of an effective carbon sink.