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Carbon storage and coastal protection: Uncovering the potential impacts of mangrove range expansion

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Abstract

Background/Questions/Methods

Mangrove range expansion along Eastern Florida is expected to continue in the absence of severe freeze events, yet the full range of ecological consequences of this rapid climate-driven shift has yet to be explored. Coastal wetlands are transitioning from predominantly herbaceous salt marsh species to arboraceous mangroves, two vegetation types with inherently different structural properties, which may significantly alter carbon (C) storage and coastal protection. We used a unique combination of field-based vegetation assessments and a chronology of remote sensing-derived land cover maps to quantify changes in extent and C storage from 2003 to 2010 in a 567-km2 wildlife refuge in the mangrove-salt marsh ecotone. In addition, we investigated coastal protection in ecotonal salt marshes and mangroves using the Natural Capital Project's Integrated Valuation of Environmental Services and Tradeoffs (InVEST) model for Coastal Protection, which was parameterized using field-based vegetation assessments from our site. Ultimately, our goal was to identify differences in ecotonal salt marsh and mangroves in terms of C storage and coastal protection in order to uncover the potential ecological impacts that may arise from future mangrove range expansion.

Results/Conclusion

We found that ecotonal mangrove stands stored twice as much C on a per area basis as salt marsh, and that over a 7-yr period, mangrove cover increased by 69% in the wildlife refuge. During this time interval, landscape C storage increased by 22% due to mangrove encroachment into salt marshes. Coastal protection models indicate that mangroves may provide an additional 5.44% in prevented erosion and may also reduce wave height and energy by an additional 12.6% and 6.2% as compared to salt marsh. The width of habitat needed to provide a 90% reduction in wave height is 133.1 ± 3.6 m for mangroves and 250.2 ± 4.7 m for salt marshes. The ecosystem value of salt marsh habitat was estimated to be 5.2% less than mangrove habitat. Overall, our findings indicate that C storage differences are largely caused by aboveground biomass at the onset of encroachment. Similarly, the coastal protection capacity of

each vegetation type can be attributed to morphological characteristics, such as density, structural complexity and stem flexibility. In all, our findings suggest that increasing mangrove cover may uptake C in coastal wetlands, while also rendering them more resilient to a future of climate change.