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A geospatial modelling approach to predict seagrass habitat recovery under multiple stressor regimes

Restoration of estuarine seagrass habitats requires a clear understanding of the modes of action of multiple interacting stressors including nutrients, climate change, coastal land-use change, and habitat modification. We have developed and demonstrated a geospatial modeling approach for predicting seagrass habitat in Narragansett Bay, R.I. Variables tested in the model included: Secchi depth, wave mixing depth and wave energy, sediment particle size and organic carbon content, unsewered coastal development on high infiltration soils, density of Canada geese, and distance to marinas and hardened shorelines. To account for spatial autocorrelation in predictive models, a spatial coordinate system relevant to seagrass establishment and spread was created based on distance along the shoreline and distance from shore. Spatial autocorrelation was built into models using either zonal averaging of residual autocorrelation terms or regression kriging. Scales of spatial autocorrelation in along-shore and off-shore directions were evaluated with spline correlograms. Prediction of seagrass absolute or average presence/absence at shoreline locations was very robust, with area-under-the-curve (AUC) values associated with receiver operator characteristic (ROC) curves of 0.95 – 0.98 following 10-fold cross-validation of models. The most influential predictor is sediment type, followed by sediment percent total organic carbon (at low Secchi depth), then salinity (as an indicator for total nitrogen (TN) gradients). Across all shorelines, our model predicts that colonized area would increase from 12% of area in the 0 to 5 meter depth zone to about 63% of area in the short term and more in the long term (as sediment organic carbon recovers) following a 40% reduction in TN. The modeling approach is being published as an EPA report with example R codes and a tutorial on how to download relevant data for modeling other estuarine systems using EPA's Estuary Data Mapper.