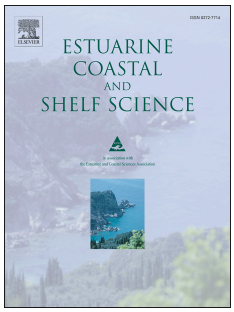
# Accepted Manuscript




Improving salt marsh digital elevation model accuracy with full-waveform lidar and nonparametric predictive modeling

Jeffrey N. Rogers, Christopher E. Parrish, Larry G. Ward, David M. Burdick

PII: S0272-7714(17)30784-9

DOI: 10.1016/j.ecss.2017.11.034

Reference: YECSS 5691

To appear in: *Estuarine, Coastal and Shelf Science*

Received Date: 31 July 2017

Revised Date: 20 November 2017

Accepted Date: 28 November 2017

Please cite this article as: Rogers, J.N., Parrish, C.E., Ward, L.G., Burdick, D.M., Improving salt marsh digital elevation model accuracy with full-waveform lidar and nonparametric predictive modeling, *Estuarine, Coastal and Shelf Science* (2018), doi: 10.1016/j.ecss.2017.11.034.

# Improving Salt Marsh Digital Elevation Model Accuracy with Full-Waveform Lidar and Nonparametric Predictive Modeling

**Jeffrey N. Rogers[1,2], Christopher E. Parrish[3,4], Larry G. Ward[1,4,6], David M. Burdick[5,6]**

**11/20/17**

**1 - Department of Earth Sciences, University of New Hampshire, Durham, NH 03824**
**2 - Center for Coastal Studies, Provincetown, MA 02657**
**3 - School of Civil and Construction Engineering, Oregon State University, Corvallis, OR 97331**
**4 - Center for Coastal and Ocean Mapping/Joint Hydrographic Center, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH 03824**
**5 - Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH 03824**
**6 - Jackson Estuarine Laboratory, School of Marine Science and Ocean Engineering, University of New Hampshire, Durham, NH 03824**

## ABSTRACT

Salt marsh vegetation tends to increase vertical uncertainty in light detection and ranging (lidar) derived elevation data, often causing the data to become ineffective for analysis of topographic features governing tidal inundation or vegetation zonation. Previous attempts at improving lidar data collected in salt marsh environments range from simply computing and subtracting the global elevation bias to more complex methods such as computing vegetation-specific, constant correction factors. The vegetation specific corrections can be used along with an existing habitat map to apply separate corrections to different areas within a study site. It is hypothesized here that correcting salt marsh lidar data by applying location-specific, point-by-point corrections, which are computed from lidar waveform-derived features, tidal-datum based elevation, distance from shoreline and other lidar digital elevation model based variables, using nonparametric regression will produce better results. The methods were developed and tested using full-waveform lidar and ground truth for three marshes in Cape Cod, Massachusetts, U.S.A. Five different model algorithms for nonparametric regression were evaluated, with TreeNet's stochastic gradient boosting algorithm consistently producing better regression and classification results. Additionally, models were constructed to predict the vegetative zone (high marsh and low marsh). The predictive modeling methods used in this study estimated ground elevation with a mean bias of 0.00 m and a standard deviation of 0.07 m (0.07 m root mean square error). These methods appear very promising for correction of salt marsh lidar data and, importantly, do not require an existing habitat map, biomass measurements, or image based remote sensing data such as multi/hyperspectral imagery.

Index words: *Spartina alterniflora*, Random Forests, TreeNet Stochastic Gradient Boosting, regression trees, CART, DEM correction