

Reconstructing Coastal Sediment Budgets from Beach- and Foredune- Ridge Morphology: A Coupled Field and Modeling Approach

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Introduction

This document contains supplemental figures, including plan-view maps of our study sites, nautical charts showing regional context, slope measurements and profiles of study transects and ridges, time-series analyses of sediment inputs, and sensitivity analyses for ridge slope/accommodation/rate of sea-level rise. A copy of the model script (MATLAB) used in this study, as well as scripts and data to examine and produce time-series from our elevation profiles, are available at our model development page <https://github.com/ciarletd/Beach-and-Foredune-Ridge> and archived under DOI 10.5281/zenodo.2575699.

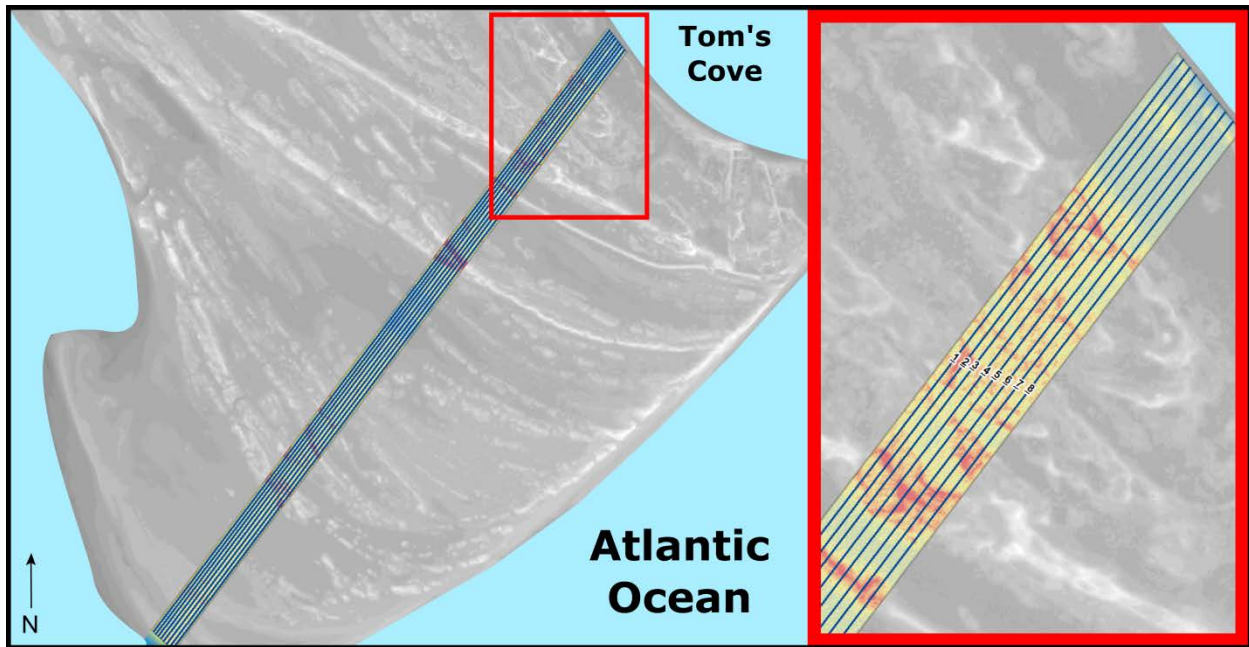


Figure S1. Plan view of study area on Fishing Point, at the southern end of Assateague Island in Virginia. Background image is CoNED (Coastal National Elevation Database) LiDAR derived elevation. The rectangular boxed area represents the ridge perpendicular transect swath, and blue lines represent individual transect profiles used to produce an average elevation profile (Figure 2). Inset with red border shows zoomed in region of transect area adjacent to Tom's Cove, at the most 'landward' section of the swath. Eight individual transect slices were utilized to produce Fishing Point's average profile, as the narrowness of the ridges required additional resolution to properly visualize.

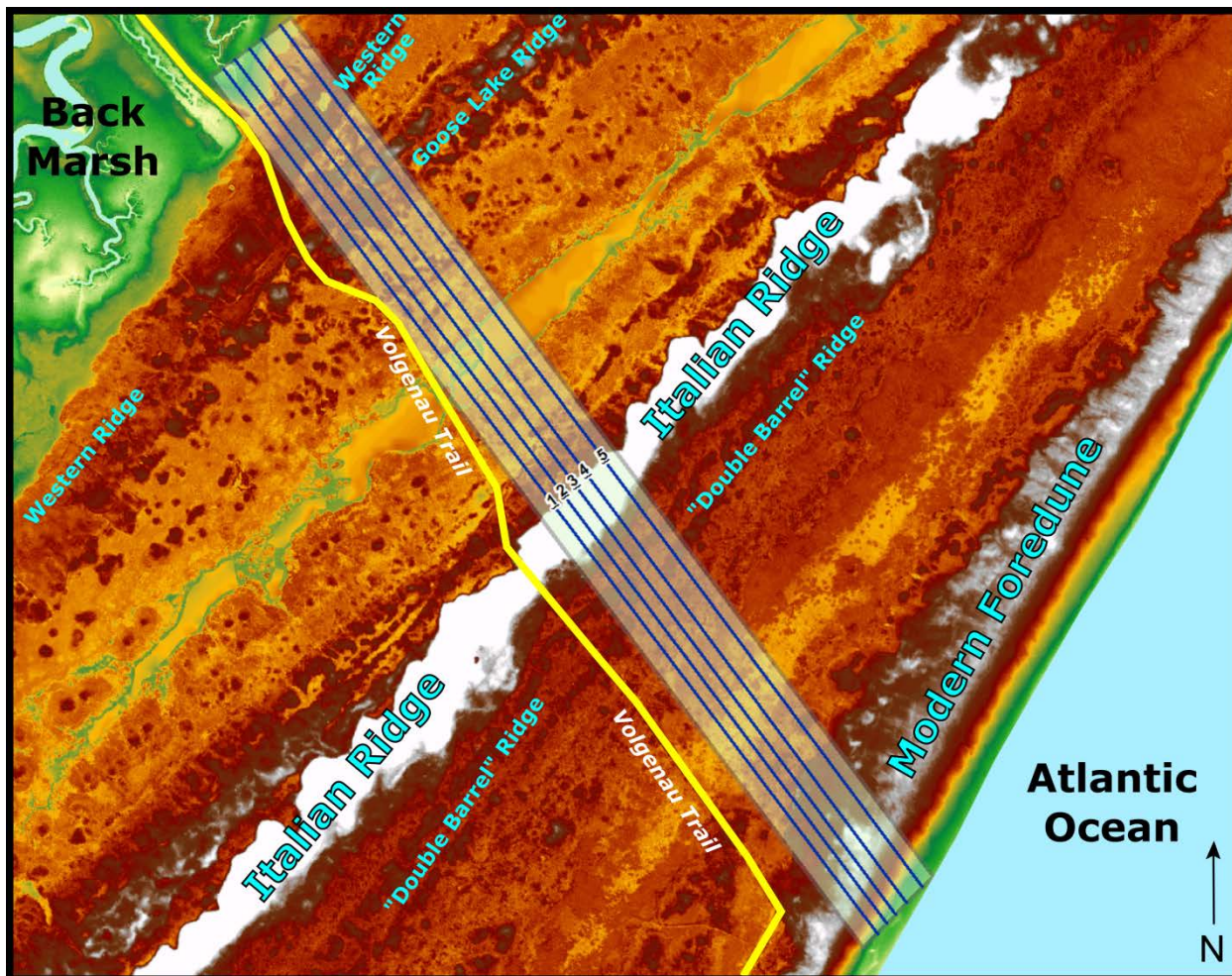


Figure S2. Plan view of study area on north Parramore Island, Virginia, with 2016 CoNED (Coastal National Elevation Database) LiDAR derived elevation. The gray boxed area represents the ridge perpendicular transect swath, and blue lines represent five individual transect profiles used to produce an average elevation profile (Figure 2).

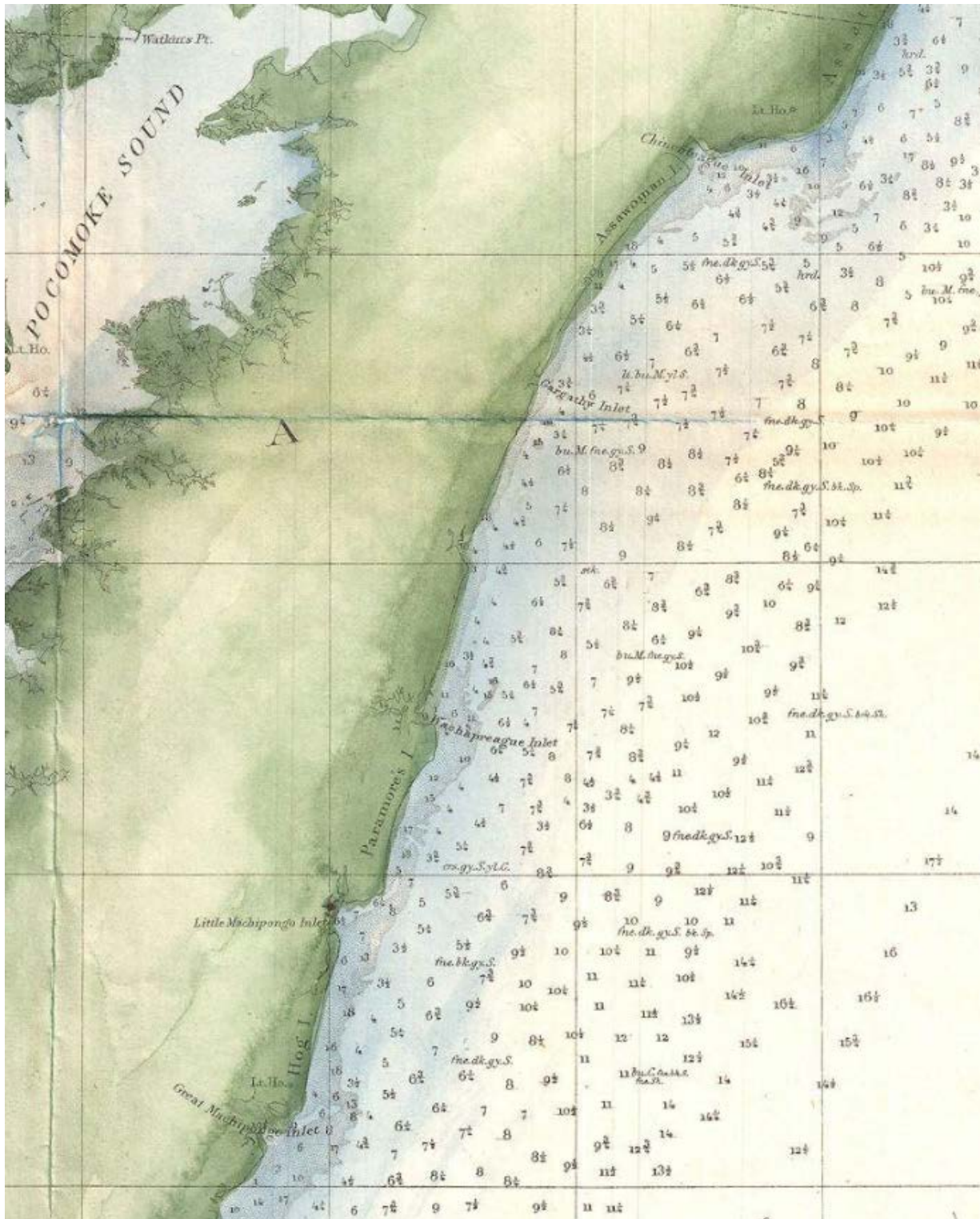


Figure S3. Clip from the Office of Coast Survey *Preliminary Chart of Delaware and Chesapeake Bays and Sea Coast From Cape Henlopen to Cape Charles*, series 1855. Fishing Point, which has yet to form, would eventually exist northeast of Chincoteague Inlet in the north, where shoals are indicated. Parramore Island (center, bottom) shown with seaward bulging southern shoreline. Depths greater than 20 feet are displayed in fathoms.

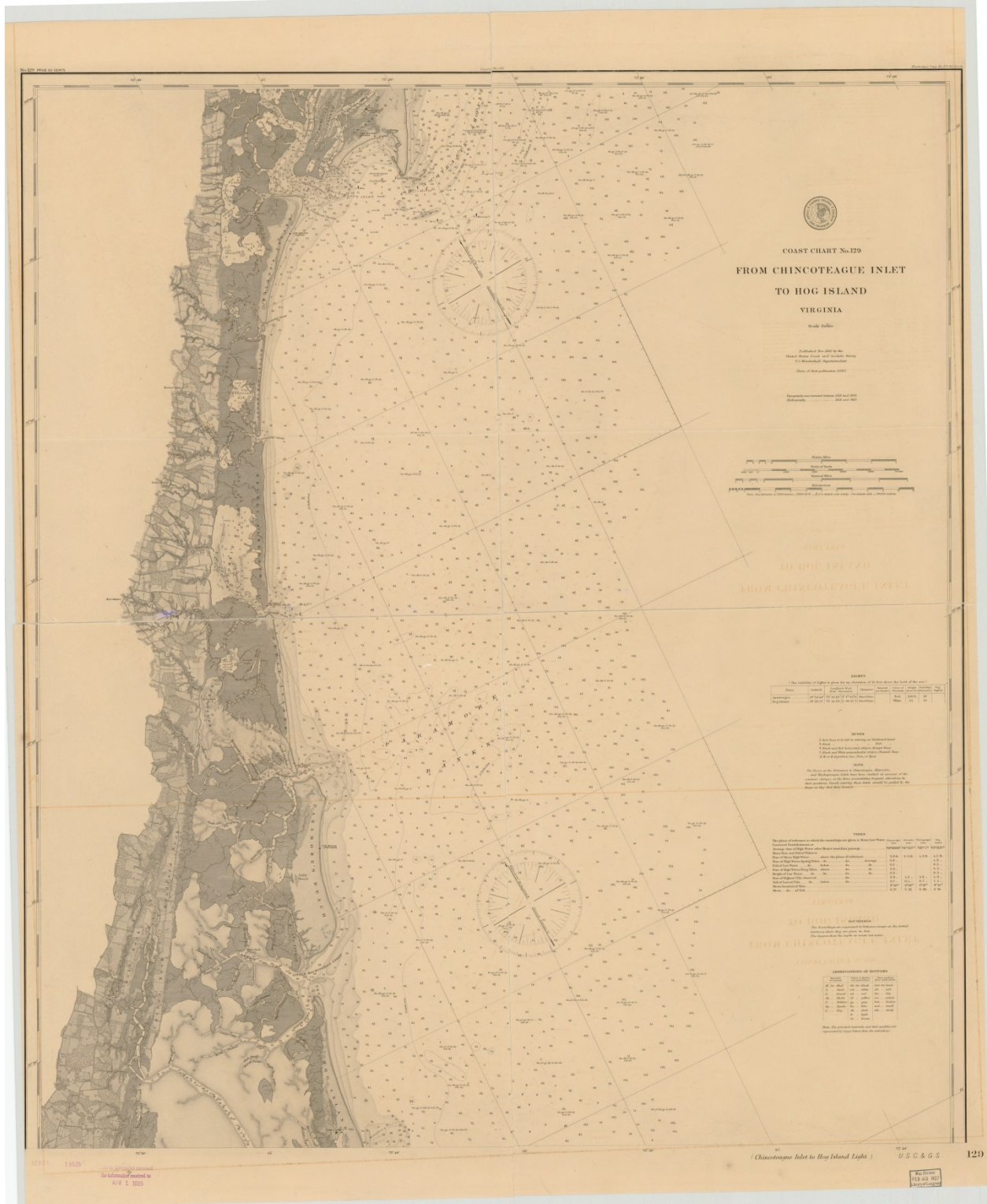


Figure S4. Office of Coast Survey nautical chart *From Chincoteague Inlet to Hog Island Virginia*, series 1895, 4th Edition. Fishing Point charted as an emerging feature in the north. Parramore Island (2nd island to bottom) shown near its maximum state of progradation.

Progression of Ridge Abandonment

Image: March, 2013



Figure S5. Aerial photo of Fishing Point showing progression of dune ridge abandonment along the cross-shore transect through time. 2013 image selected as base due to high resolution and contrast. Map data: Google, USDA Farm Service Agency.

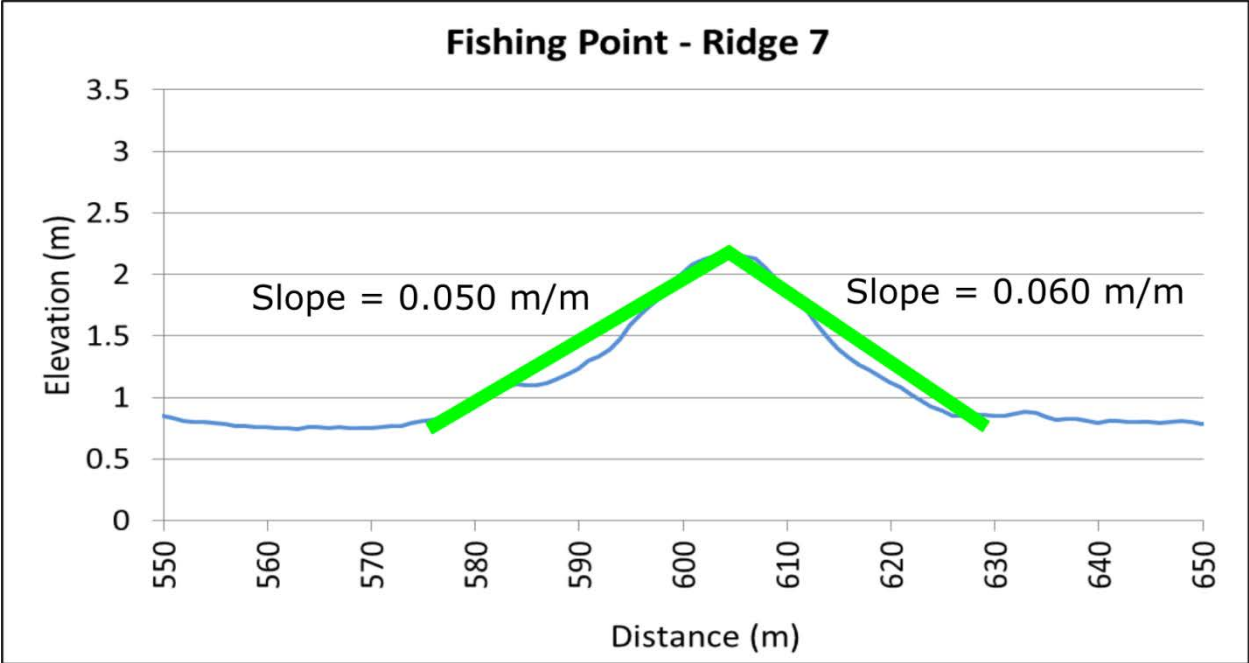


Figure S6. Detailed cross section of Fishing Point Ridge #7, depicting slope of dune flanks. Elevation relative to NAVD88 is shown on the y axis, while the x axis indicates cross shore distance increasing in the seaward direction (south).

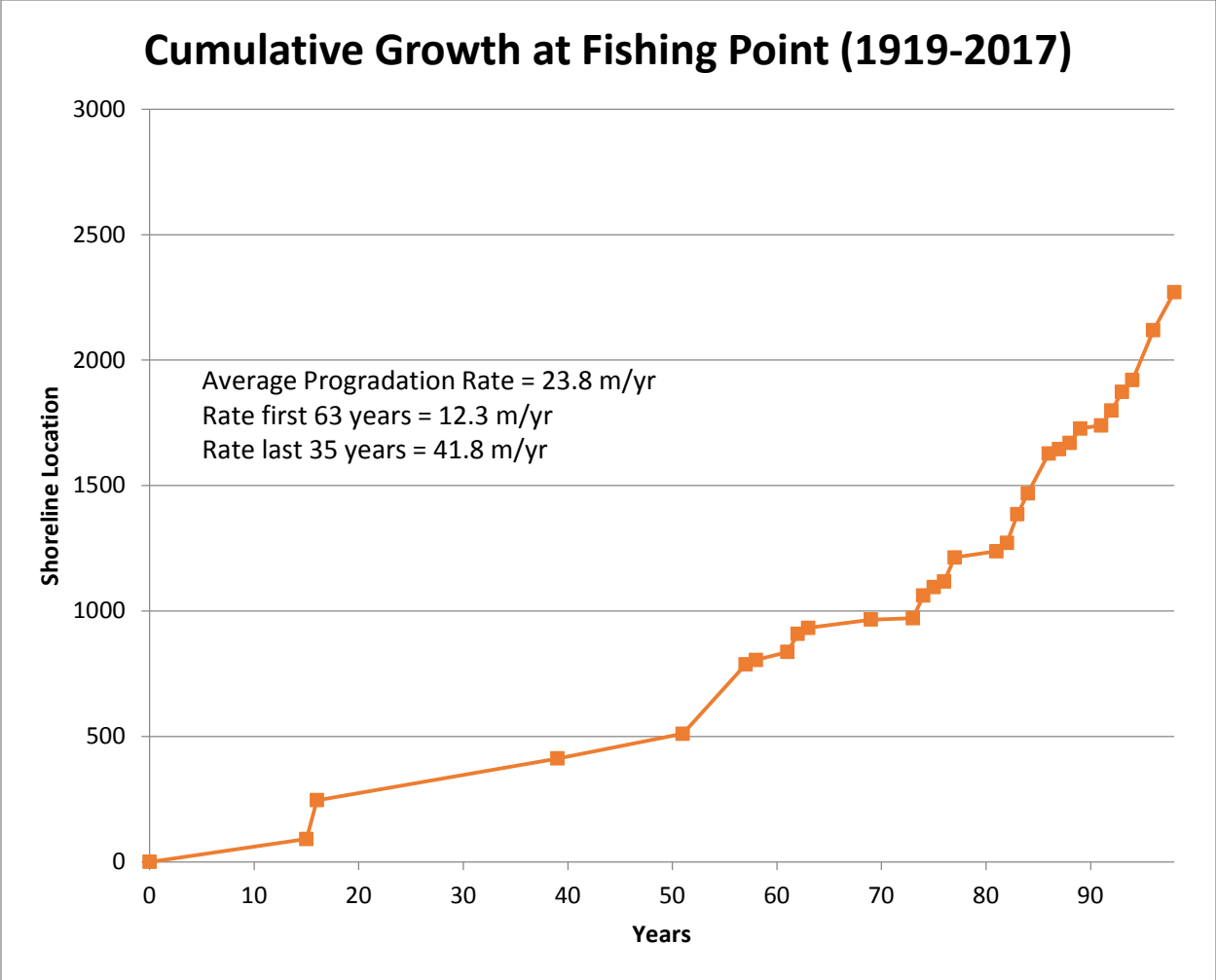


Figure S7. Cumulative shoreline growth along the longest ridge-perpendicular transect of Fishing Point, from 1919 to 2017. From 1919 to 1982, the rate of shoreline advance averaged 12.3 m/yr. After 1982, progradation accelerated to 41.8 m/yr.

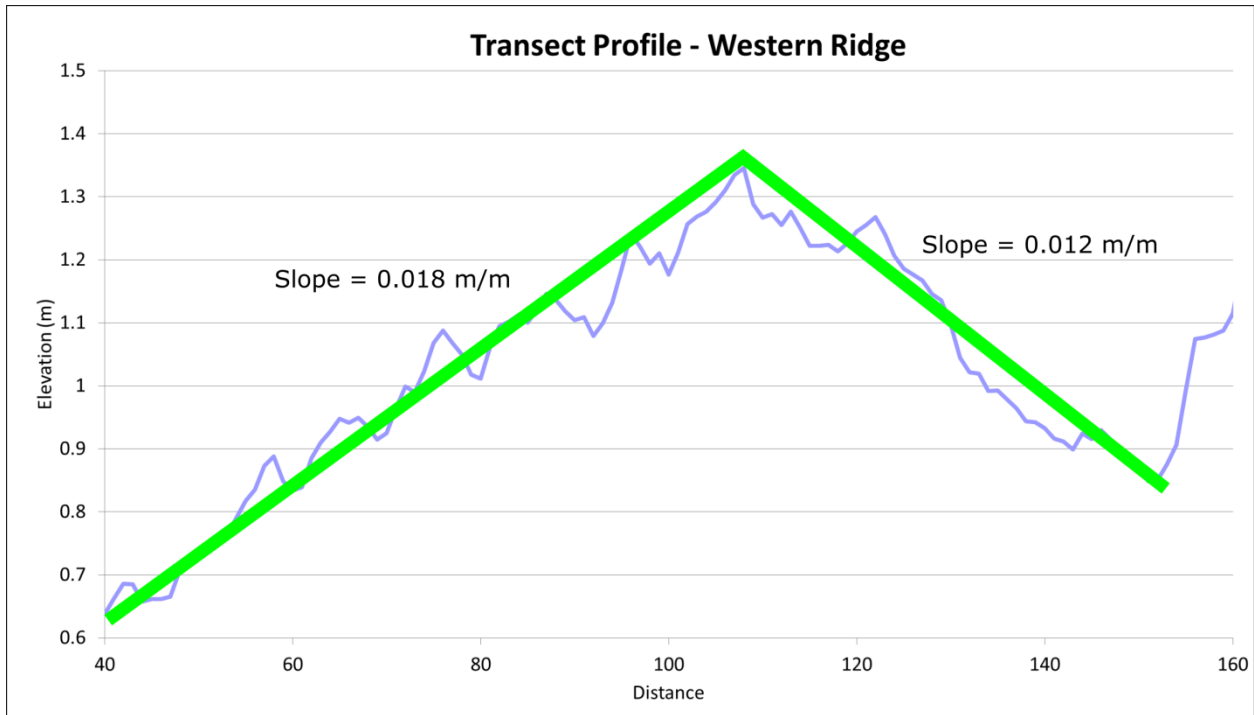


Figure S8. Detailed cross section of Western Ridge, depicting slope of dune flanks. Elevation relative to NAVD88 is shown on the y axis, while the x axis indicates cross shore distance increasing in the seaward direction (east).

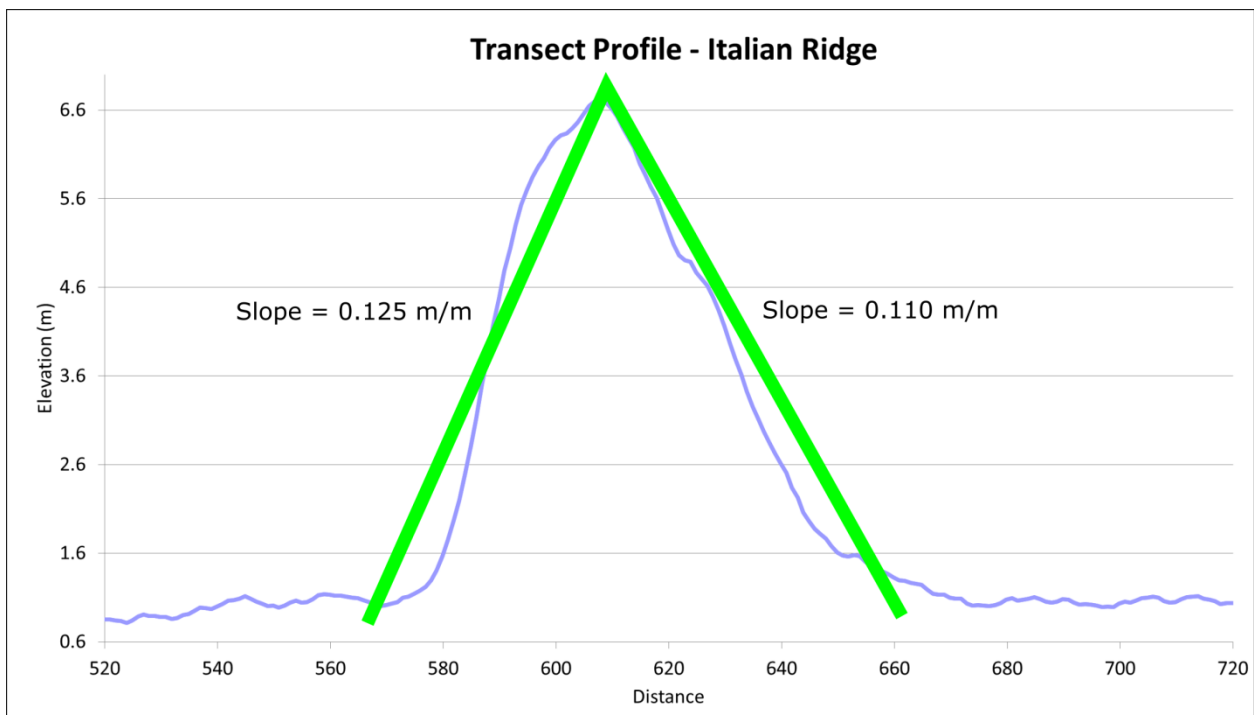


Figure S9. Detailed cross section of Italian Ridge, depicting slope of dune flanks. Elevation relative to NAVD88 is shown on the y axis, while the x axis indicates cross shore distance increasing in the seaward direction (east).

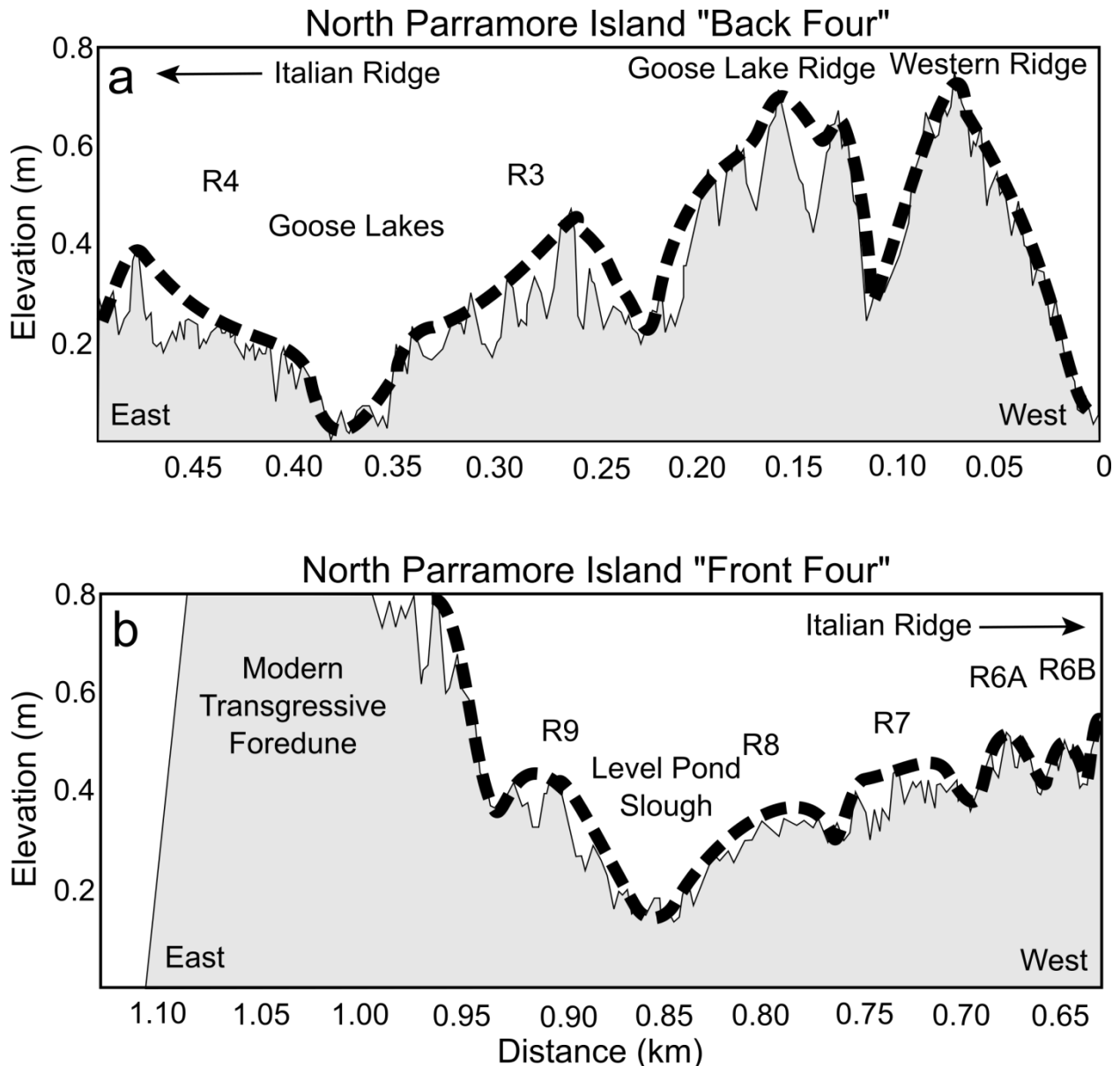


Figure S10. Elevation cross section of the (a) "Back Four" and (b) "Front Four" ridges west and east of Italian Ridge, respectively, with distance increasing in the seaward direction. The dashed line is a subjective impression of what the ridges might look like with ideal preservation (in reality, ridges have an irregular profile, presumably due to post-abandonment erosion and local vegetation effects). For example, Goose Lake Ridge appears to have 4 ridge crests in the profile, but these are actually surface variations generated by hummocky topography that are apparent in planar view. Ridges are numbered from landward to seaward, with the most substantial ridges, Western Ridge (R1) and Goose Lake Ridge (R2) annotated.

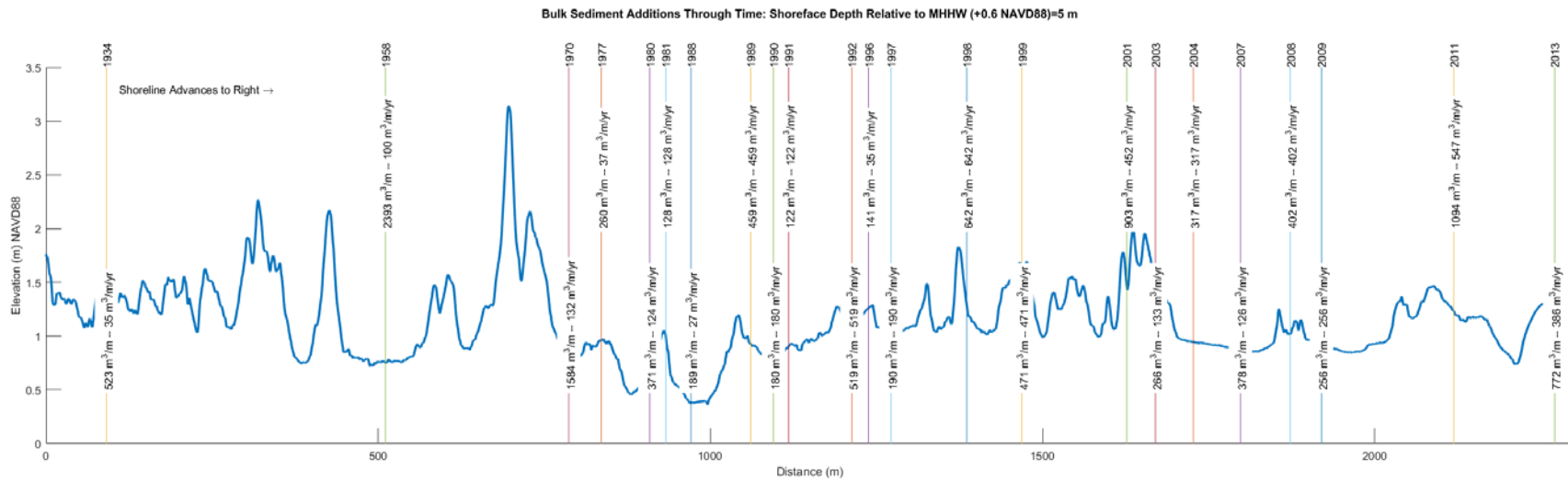


Figure S11. Elevation profile of Fishing Point transect overlain with former shoreline locations. The bulk sediment additions to the system are shown for each advance in shoreline location, calculated by computing the cross section volume under the elevation profile plus the shoreface depth.

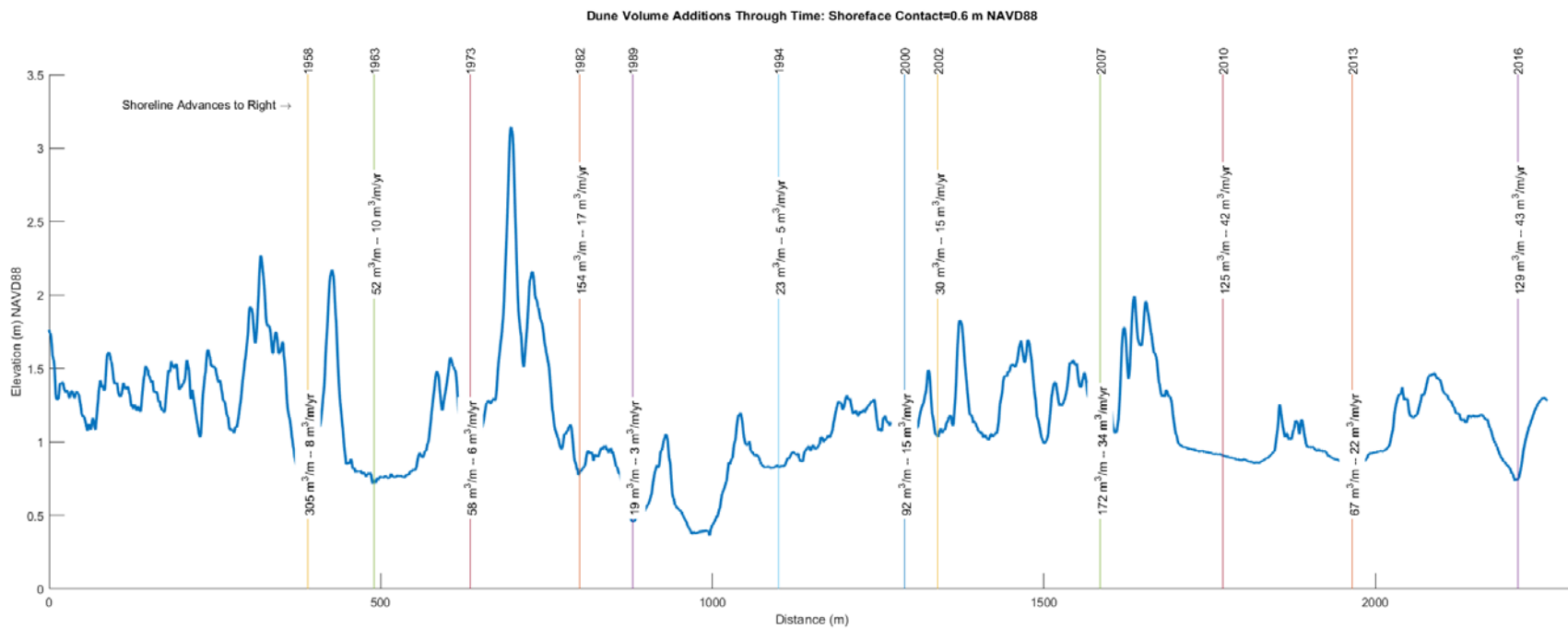


Figure S12. Elevation profile of Fishing Point transect overlain with locations marking the dates when ridges or sets of ridges became relict. Dune volume additions with the progression of ridge inactivity are calculated by computing the cross section volume under the elevation profile to MHHW.

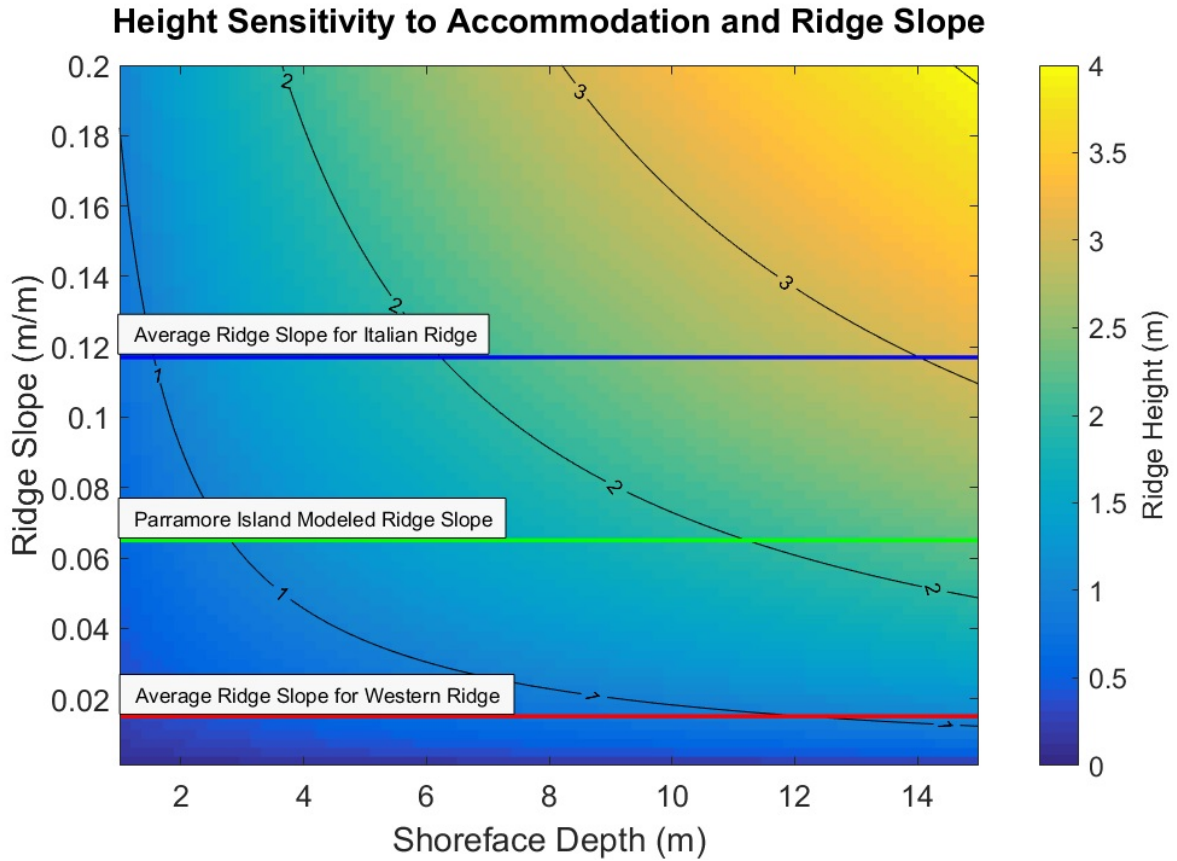


Figure S13. Ridge height sensitivity to ridge slope and shoreface depth (accommodation) after 200 years, using $L_s = 5$ m, $L_c = 117$ m, $Q_s = 15$ m³/m/yr, and $Q_D = 0.7$ m³/m/yr. The average ridge slope for Western Ridge, Parramore Island (red) is 0.015 m/m, and the average ridge slope for Italian Ridge, Parramore Island (blue) is 0.117 m/m.

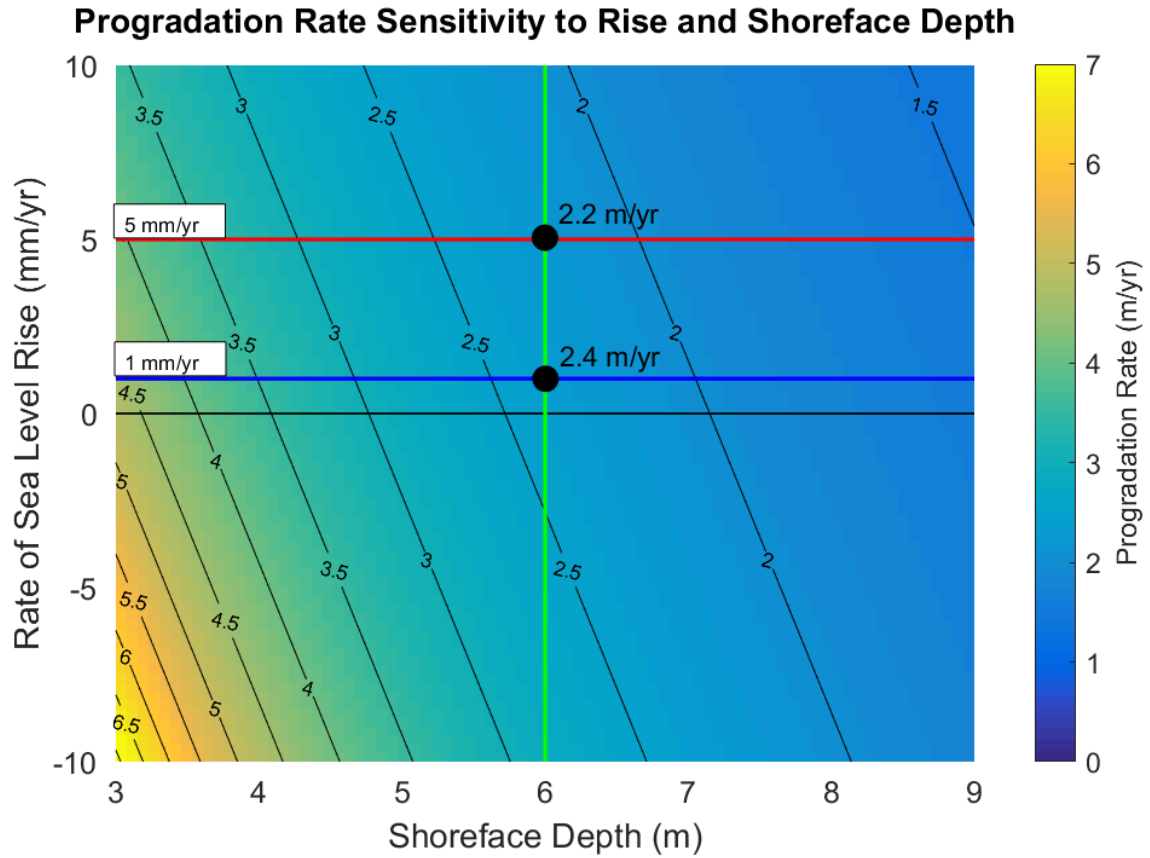


Figure S14. Progradation rate sensitivity to rate of sea level rise and shoreface depth (accommodation) after 100 years, using $L_S = 5$ m, $L_C = 117$ m, $Q_S = 15$ m³/m/yr, and $Q_D = 0.7$ m³/m/yr. We plot the progradation rate of Parramore Island as modeled in Figure 9b from 900 to 1000 years, with a sea level rise rate of 1 mm/yr (blue) at a shoreface depth of 6 meters (green). We subsequently plot the rate of progradation at 5 mm/yr (red), demonstrating a 0.2 m/yr decrease in progradation rate.

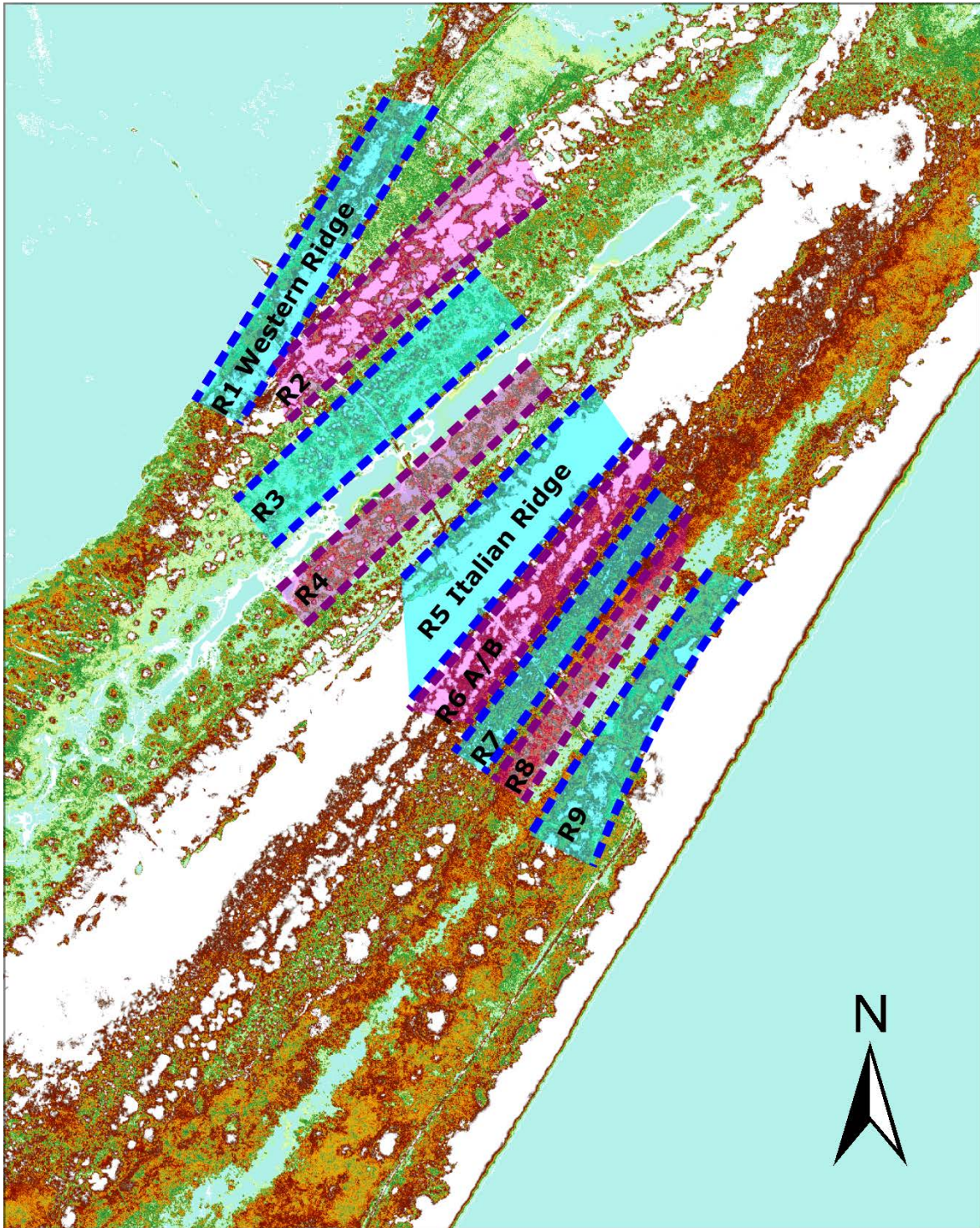


Figure S15. Plan view of study area on north Parramore Island, Virginia, with 2016 CoNED (Coastal National Elevation Database) LiDAR derived elevation. This image is shaded between 0.7 and 1.2 m NAVD88 in order to enhance the detail of the ridges, highlighted here in alternating shades of blue and violet. Elevations in white are out of range.