Appendix

A1: Turbulent Kinetic Energy Modeled by Plant and Confounding Variables

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| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Rotational Stiffness (N\*m/rad) | -3.88×10-3 | 1.10×10-3 | 5.13×10-4 |
| Plant Surface Area (cm2/cm of shoreline) | -3.71×10-4 | 3.19×10-5 | 2.20×10-16 |
| Bar Depth (cm) | 7.07×10-3 | 8.90×10-4 | 2.35×10-13 |
| Bar Location (cm from wave paddle) | 4.59×10-4 | 4.46×10-5 | 2.20×10-16 |
| Slope of Shore (degrees) | -2.26×10-3 | 2.98×10-4 | 1.98×10-12 |
| Intercept | -0.0603 | 0.0618 | 2.20×10-16 |
| Adjusted R2 | 0.594 |  |  |
| Overall *p* Value | 2.20×10-16 |  |  |
| n = 180 |  |  |  |

Notes: Intercept and adjusted R2 parameter describe the relation of the best-fit straight line to data points generated using the variables that are considered significant in the respective models. The p values describe the statistical significance of the respective modeled variable (listed in the table) with respect to the main parameter of the model (listed in the table header). The overall p value describes the overall statistical significance of all significant model variables with respect to the main model parameter. The plant variables that were modeled were plant surface area, rotational stiffness, fine root biomass, coarse root biomass, mycorrhizal colonization (only significant variables are shown in this model summary). Confounding variables that were modeled were the water depth at the location of the ADV probe head, the water depth at the largest sand bar, the location of the largest sand bar, the slope of the shoreline (measured from sand bar to base of the dune scarp), and significant wave height (varied slightly from trial to trial due to variations in the wave flume fill level, as well as slight variations in wave reflections). A larger sand bar (smaller sand bar depth) that was further from the shore (closer to the paddle) created more turbulence. A steeper sloped shoreline also tended to correspond to less swash zone turbulence. It should be noted that coarse root biomass was collinear with rotational stiffness and could be substituted into this model (though coarse root biomass was slightly less significant compared to rotational stiffness). Potentially, unearthed coarse roots could function similarly to aboveground structures, breaking up wave energy. Lastly, it should be noted that 2.20×10-16 is the smallest number greater than zero that can be stored in R outputs (the statistical program used for this modeling).

A2: Mean Swash Velocity Modeled by Plant and Confounding Variables

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| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Rotational Stiffness (N\*m/rad) | -0.0109 | 0.00537 | 0.0440 |
| Plant Surface Area (cm2/cm of shoreline) | -1.06×10-3 | 1.54×10-4 | 9.47×10-11 |
| Bar Depth (cm) | 0.0221 | 3.68×10-3 | 1.11×10-08 |
| Slope of Shore (degrees) | 9.71×10-3 | 1.44×10-3 | 2.25×10-10 |
| Intercept | 0.0780 | 0.0235 | 1.08×10-3 |
| Adjusted R2 | 0.468 |  |  |
| Overall *p* Value | 2.20×10-16 |  |  |
| n = 180 |  |  |  |

Notes: The plant variables that were modeled were plant surface area, rotational stiffness, fine root biomass, coarse root biomass, mycorrhizal colonization (only significant variables are shown in this model summary). Confounding variables that were modeled were the water depth at the location of the ADV probe head, the water depth at the largest sand bar, the location of the largest sand bar, the slope of the shoreline, and significant wave height. When larger sand bars formed (smaller sand bar depth), mean swash velocity was increased. A steeper sloped shoreline also tended to increase mean swash velocity.

A3: Wave Reflection Coefficient Modeled by Plant and Confounding Variables

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| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Fine Root Biomass (mg/L soil) | -1.08×10-4 | 3.15×10-5 | 9.46×10-4 |
| Plant Surface Area (cm2/cm of shoreline) | -1.14×10-3 | 1.52×10-4 | 5.39×10-11 |
| Bar Depth (cm) | 0.0429 | 4.99×10-3 | 3.88×10-13 |
| Bar Location (cm from wave paddle) | 1.70×10-3 | 2.42×10-4 | 5.12×10-10 |
| Slope of Shore (degrees) | 4.05×10-3 | 1.51×10-3 | 8.67×10-3 |
| Intercept | -4.73 | 0.670 | 4.41×10-10 |
| Adjusted R2 | 0.618 |  |  |
| Overall *p* Value | 3.13×10-16 |  |  |
| n = 90 |  |  |  |

Notes: The plant variables that were modeled were plant surface area, rotational stiffness, fine root biomass, coarse root biomass, mycorrhizal colonization (only significant variables are shown in this model summary). Confounding variables that were modeled were the water depth at the largest sand bar, the location of the largest sand bar, the slope of the shoreline, and significant wave height. A larger sand bar (smaller sand bar depth) that was further from the shore (closer to the paddle) decreased wave reflection and increased the shoreline’s wave energy dissipation. A steeper sloped shoreline also tended to increase wave reflection.

A4: Peak Sediment Shear Strength Modeled by Belowground Plant Variables

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| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Fine Root Biomass (mg/L soil) | 1.45 | 0.622 | 0.0317 |
| Intercept | 1.04×103 | 312 | 0.0053 |
| Adjusted R2 | 0.308 |  |  |
| n = 15 |  |  |  |

A5: Cumulative Sediment Shear Strength Modeled by Belowground Plant Variables

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| --- | --- | --- | --- |
| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Fine Root Biomass (mg/L soil) | 18.7 | 5.86 | 7.01×10-3 |
| Intercept | 1.04×103 | 2.94×103 | 0.0136 |
| Adjusted R2 | 0.397 |  |  |
| n = 15 |  |  |  |

A6: Dune Erosion Modeled by Plant and Confounding Variables

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| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Fine Root Biomass (mg/L soil) | -1.213×107 | 4.38×103 | 0.018 |
| Plant Surface Area (cm2/cm of shoreline) | -377 | 10.3 | 0.024 |
| Initial Cross-Shore Centroid (cm from Wave Paddle) | 257 | 98.9 | 0.0036 |
| Intercept | -3.95×105 | 13.6×105 | 0.031 |
| Adjusted R2 | 0.743 |  |  |
| Overall *p* Value | 3.9×10-04 |  |  |
| n = 15 |  |  |  |

Notes: The plant variables that were modeled were plant surface area, rotational stiffness, fine root biomass, coarse root biomass, mycorrhizal colonization (only significant variables are shown in this model summary). The confounding variables that were modeled were initial cross-shore centroid shift (small random variations were generated when the dune and shore are formed prior to trial) and significant wave height. More fine roots and plant surface area (aboveground) decreased erosion. When sediment was initially set up further away from the wave paddle, erosion in the near-shore zone during the wave trial was increased.

A7: Dune Scarp Retreat and Cross-Shore Centroid Shift Modeled by Plant and Confounding Variables

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| **Dune Scarp Retreat** | | | |
| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Fine Root Biomass (mg/L soil) | -2.98×104 | 9.49×103 | 0.0086 |
| Plant Surface Area (cm2/cm of shoreline) | -1.083 | 0.236 | 6.12×10-4 |
| Intercept | 61.46 | 1.103 | 7.4×10-16 |
| Adjusted R2 | 0.697 |  |  |
| Overall *p* Value | 3.1×10-04 |  |  |
| n = 15 |  |  |  |
| **Cross-Shore Centroid Shift** | | | |
| **Variable** | **Coefficient** | **Standard Error** | ***p* Value** |
| Fine Root Biomass (mg/L soil) | -1.14×104 | 3.03×103 | 0.0031 |
| Plant Surface Area (cm2/cm of shoreline) | -0.223 | 0.0709 | 0.0094 |
| Initial Cross-Shore Centroid (cm from Wave Paddle) | 0.513 | 0.0684 | 1.2×10-5 |
| Intercept | -693 | 93.9 | 1.39×10-5 |
| Adjusted R2 | 0.901 |  |  |
| Overall *p* Value | 2.1×10-06 |  |  |
| n = 15 |  |  |  |

Notes: The plant variables that were modeled were plant surface area, rotational stiffness, fine root biomass, coarse root biomass, mycorrhizal colonization (only significant variables are shown in this model summary). The confounding variables that were modeled were initial cross-shore centroid shift and significant wave height. More fine roots and plant surface area (aboveground) decreased scarp retreat and cross-shore centroid shift. Additionally, when sediment was initially set up further away from the wave paddle, the sediment profile centroid shifted further offshore.