Notice of the Final Oral Examination for the Degree of Doctor of Philosophy of

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“The Role of Large Woody Debris on Sandy Beach-Dune Morphodynamics”

Department of Geography

Thursday, April 25, 2019
1:00 P.M.
Clearihue Building
Room B007

Supervisory Committee:
Dr. Ian Walker, Department of Geography, University of Victoria (Supervisor)
Dr. Bernard Bauer, Department of Geography, UVic (Member)
Dr. J. Vaughn Barrie, School of Earth and Ocean Sciences, UVic (Outside Member)

External Examiner:
Dr. John Gillies, Division of Atmospheric Sciences, Desert Research Institute (Reno)

Chair of Oral Examination:
Dr. Erin Kelly, Department of English, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

Coastal foredune evolution involves complex processes and controls. Although a great deal is known about the effects of vegetation cover, moisture, and fetch distance on sediment supply, and of topographic forcing on airflow dynamics, the role of large woody debris (LWD) as a modulator of sediment supply and a control on foredune growth is understudied. Large assemblages of LWD are common on beaches near forested watersheds and collectively have a degree of porosity that increases aerodynamic roughness and provides substantial sand trapping volume. To date, no research has attempted to understand the geomorphic role that LWD matrices, as a whole, have as roughness elements affecting airflow and sediment transport across a beach-dune system, or, what the long-term implications of these impacts are on beach and foredune erosion recovery and evolution. This four-year research initiative investigated the role of a LWD matrix on beach-dune morphodynamics on West Beach, Calvert Island on the central coast of British Columbia, Canada.

This study integrated data from research that spanned three temporal scales, 1) event-scale (10 min) flow and sediment transport patterns, 2) daily frequency and relative magnitude of landscape changing events, 3) seasonal to interannual-scale volumetric and LWD changes. An event-scale experiment to characterise airflow dynamics and related sand transport patterns showed that LWD distinctly alters wind flow patterns and turbulence levels from that of incoming flow over a flat beach. Overall, mean wind speed and fluctuating flow properties declined as wind transitioned across the LWD. Streamwise mean energy was converted to turbulent energy, however, the reductions in mean flow properties were too great for the increased streamwise turbulence to have an effect on transport. In response to these flow alterations and more limited sand transport pathways to the foredune, sediment flux was reduced by 99% in the LWD compared to the open beach, thereby reducing sand supply to the foredune. Sand grains rebounding off of the LWD were carried higher into the flow field resulting in greater mass flux recorded at 20-50 cm in the LWD as opposed to the flat beach. This effect was only recorded 6 m into the LWD. As such, LWD has the potential to modulate rates of foredune recovery, growth, and evolution.

Time-lapse photography collected at 15 min intervals during the study revealed that storm events lead to wave-induced erosion of the backshore and reworking of the LWD matrix. The exposed LWD matrix subsequently traps aeolian sediment that leads to rapid burial of the LWD and building of a raised platform for emergent vegetation. However, infilling of the accommodation space within the LWD matrix is so rapid, that sediment starvation of the foredune is short-lived. While the LWD at this site does trap sediment in the backshore, helping to protect the dune from scarping, LWD at this study site maintains an overall lower impact on transport to the foredune. Critical to this relationship is the frequency and magnitude of nearshore events that erode the beach periodically and re-organize the LWD matrix, which directly impacts the ability of LWD to store sediment and modulate transport to the foredune. A conceptual model exploring these relationships is presented.