University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (University of Victoria, 2014)

"Foredune morphodynamics and seasonal sediment budget patterns: Humboldt Bay National Wildlife Refuge, Northern California, USA"

Department of Geography

August 11, 2017
11:00 A.M.
David Turpin Building
A136

Supervisory Committee:
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Dr. Bernard O. Bauer, Department of Geography, UVic (Member)
Ms. Andrea J. Pickart, US Fish and Wildlife Service (Outside Member)

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Abstract

Delivery of sediment to the beach-dune complex along the northern California coast, as elsewhere, is controlled by littoral and aeolian processes governed by oceanic and meteorological conditions such as wind speed and direction, wave characteristics and water level fluctuations (e.g., tides, storm surge, sea-level rise). Patterns of sediment deposition on foredunes are not only dependent on wind regime and sediment availability, but also on the zonation, density and physical structure of dominant vegetation assemblages. Meteorological patterns and disturbance to vegetation concurrently influence foredune response and recovery to erosive wind, wave and water level events. As such, seasonal to interannual patterns of foredune morphodynamics and sediment budgets may be altered following periods of both environmental and human induced vegetation disturbance (i.e., seasonal phenology, species introduction, dynamic restoration). The developmental stage of foredune evolution and long-term position of the foredune complex can therefore be disrupted or altered depending on the specific interaction of sediment supply, vegetation cover and wind regime.

At a site within Humboldt Bay National Wildlife Refuge (HBNWR), near Arcata, California, seasonal to interannual periods of disturbance from high impact storm events, invasive vegetation and initial stages of dynamic restoration influence longer-term beach-dune sediment budget patterns and evolution of the foredune. A long-term (75-year) north-to-south alongshore gradient in foredune response was observed during the study period, with maximum rates of progradation (up to +0.51 m a-1) and greater foredune volumes at the north, and maximum foredune retreat (up to -0.49 m a-1) and larger erosive feature areas to the south. Bi-directional littoral drift was observed with seasonal signatures. During winter months, the dominant drift direction was from the south to the north, accompanied by large waves, high water levels and beach erosion. In the summer, wind and wave directions were out of the NW, combined with north-to-south littoral drift and significant sediment input to the northern beaches. These summer conditions result in high sediment deposition on the beach during the summer months (volumetric increases up to +0.23 m3 m-2) and resultant beach and foredune re-building following the winter storm events that erode the beach, placing sediment in the nearshore or offshore zones. During drier summer transport conditions, sediment availability on the beach promotes scarp fill and subsequent foredune recovery through sand ramp building at the toe of the foredune, contributing to net positive rates of elevation and volume accumulation on the foredune stoss (up to +1.20 m a-1). Following a comprehensive morpho-ecological model of foredune evolution (Hesp 1988; 2002), foredune progradation in the north alongside net positive sediment budgets following vegetation disturbance indicate the presence of stage 1 foredunes. Further south, lower vegetation densities and evidence of limited sediment availability perpetuate a classification of stage 3 developed foredunes, characterized by shorter more hummocky foredune morphologies as the beach-dune system is unable to fully recover following seasonal storms. This study explores the link between varying oceanic, meteorological and vegetation zonation patterns and coastal foredune morphodynamics at the HBNWR to provide coastal managers with a local context of foredune erosion and accretion at multiple temporal scales, around which future management strategies may be implemented.