

# MONITORING A NATURAL COBBLE BERM TO INFORM NATURE-BASED SOLUTIONS FOR HIGH-ENERGY COASTS

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## INTRODUCTION

Dynamic revetments (or cobble berms) have emerged in the U.S. Pacific Northwest coastal community as a form of nature-based shoreline stabilization that can be effective along high-energy coasts. Dynamic revetment material is intended to be mobile, resulting in a dynamic profile that adjusts under varying wave and water level conditions by absorbing and dissipating wave energy. Studies of gravel and cobble beaches have observed increases in crest elevation and/or volume during high-energy events (Allan et. al., 2003; Allan et. al., 2004; Everts et. al., 2002), making them more resilient relative to their sandy counterparts. Compared to more conventional, hard shoreline stabilization measures, like rip rap revetments or sea walls, dynamic revetments utilize smaller (often cheaper) material and require simpler construction methods. Because their appearance resembles naturally occurring beaches (Figure 1), they can be preferred from an aesthetic and regulatory standpoint (Allan et. al., 2016). Some installations have recruited sediment and large woody debris, helping to restore critical habitat functions and recreational opportunities that were previously threatened by chronic erosion (Weiner et. al., 2019).

Because of these advantages over more conventional structures, dynamic revetments have increasingly been selected as the preferred shoreline stabilization measure to mitigate shoreline erosion and coastal flooding. However, the environmental conditions under which this type of structure can be effective are not well defined. Further, engineering design guidance and standards have yet to be developed, creating challenges during planning, design, and permitting. The lifecycle costs of these nature-based structures are difficult to estimate due to lack of confidence in predicting the magnitude and frequency of maintenance needed throughout the design lifetime. To address these uncertainties, more documented case studies, quantitative monitoring results, and lessons learned from dynamic revetment installations are needed to inform future project design and implementation efforts.

To advance our understanding of nature-based dynamic revetments, this work evaluates five years of monitoring data of a natural composite beach near Kalaloch in Northwest Washington State. The beach consists of a natural cobble berm, which backs a sandy foreshore and fronts a coastal bluff. The site serves as a natural analog to installed dynamic revetments elsewhere along Washington's Pacific Ocean shoreline. By studying the geometry, morphology, and composition of this naturally occurring feature, we can better define the types of shorelines suited for successful dynamic revetment

installations and inform future design and implementation of nature-based shoreline stabilization.

## METHODS

The Washington State Department of Ecology's Applied Coastal Research and Engineering (ACRE) team began quarterly monitoring the Kalaloch natural cobble berm in 2019. Data collection includes real-time kinematic differential GPS topographic surveys, sediment samples, CobbleCam (a photogrammetric sediment characterization method well suited for gravel and cobble sized material), ground photos, and Radio Frequency Identification (RFID) rock tracking. These data allow our team to evaluate seasonal changes in berm geometry, elevations, substrate size/gradation, and cobble mobility.



Figure 1 - Plat A: naturally occurring composite beach at Kalaloch, Washington with a cobble berm backing a sandy foreshore; Plat B: constructed dynamic revetment at North Cove, Washington.

## OUTCOMES & IMPLICATIONS

This analysis will characterize the profile of the natural berm, the spatial variation in geometric parameters, seasonal profile variation, and how the berm geometry compares to the design and adjusted profiles of constructed dynamic revetments elsewhere along the Washington coast. The substrate and CobbleCam data will be analyzed to observe longshore and cross-shore trends in substrate composition. Rock tracking data provides valuable insights on cobble mobility, which can help inform post-construction transport and maintenance needs for dynamic revetment installations. By studying a naturally occurring feature, this research extracts valuable, quantitative information to further our understanding of composite beaches in high energy wave environments, a topic that has received relatively little attention in scientific literature (Bayle et. al., 2020). This information can help improve the planning, design and implementation of nature-based shoreline stabilization and flood prevention measures along other vulnerable coasts.

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