Case Study: Dynamic Revetment

North Cove, Washington

Cobble and woody debris move with waves, providing erosion control without increasing erosion along adjacent shorelines. (Photo credit: Jackson Blalock, The Nature Conservancy)

At a Glance

Location	North Cove, Washington
Hazard(s) Addressed	Coastal Erosion and Flooding
Shoreform	Beach
Adaptation Strategy	Structural Accommodation
Adaptation Action	Natural materials such as cobbles and wood are placed along a chronically eroding shore to absorb wave energy. Wave energy redistributes these materials across the beach, which helps rebuild the beach and dune system.
Lessons Learned	• Design with nature by using natural processes to your advantage. • Pay attention to how your project interacts with the shoreline: adaptive management and regular adjustments to the project keep it functioning as planned. • Get all potential partners and affected parties in the same room. Create a conversation focused on collaboration.
Project Team	Washaway No More, North Willapa Harbor Grange, Pacific County Drainage District No.1, private landowners, Pacific Conservation District, Washington State Department of Ecology
Budget	Over $681,000
Time	Ongoing (initial testing of dynamic cobble began in 2016)
Contact	David Cottrell, Pacific County Drainage District No.1 cranberrydavid@yahoo.com

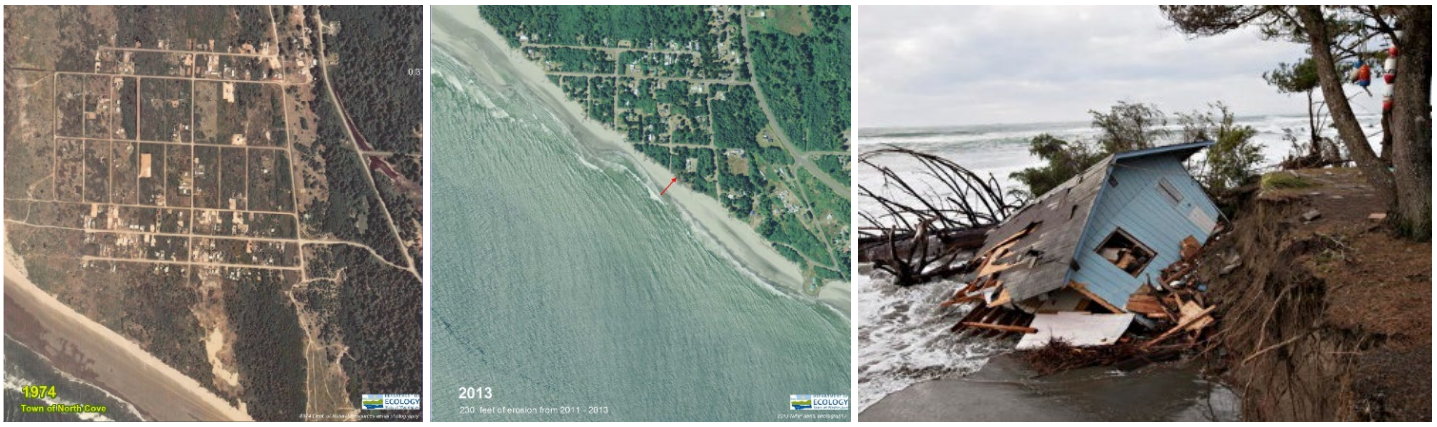
Context and Motivations

"[Water and increasing erosion] were approaching the tide gates and all the cranberry land was going to go. It could be one major storm, and you know, the buck stops here. We've got to do something, or else we are all going to be gone."

-Connie Allen, North Willapa Harbor Grange and Washaway No More

The rural community of North Cove has been an erosion hotspot for over a century, as the tidal channel at Willapa Bay's mouth has migrated northward. Many homes have already been destroyed, while Highway 105 and many more homes are threatened as land continues to be lost to the ocean. Local cranberry bogs provide livelihoods for the community and supply two thirds of cranberries grown in Washington. These low-lying bogs are at risk of permanent destruction if saltwater crosses the last remaining barrier, which is a thin strip of land bordering Highway 105. The community has tried several strategies to combat chronic erosion, and the North Cove Dynamic Revetment is the most effective yet.

The site's location in Washington (left), north of Willapa Bay's mouth (center), and next to Hwy 105 and cranberry bogs (right). (Image credit: Google Earth)



The town of North Cove in 1974 (left) and 2013 (center, red arrow indicates direction of shoreline retreat). This chronic erosion has destroyed roads and homes (right). (Left and center image credit: Washington State Department of Ecology; right photo credit: David Ryder, Reuters)

Partners, Permits and Funding

Project Lead: Washaway No More (a collaboration between Pacific County Drainage District No. 1 and North Willapa Harbor Grange #947)

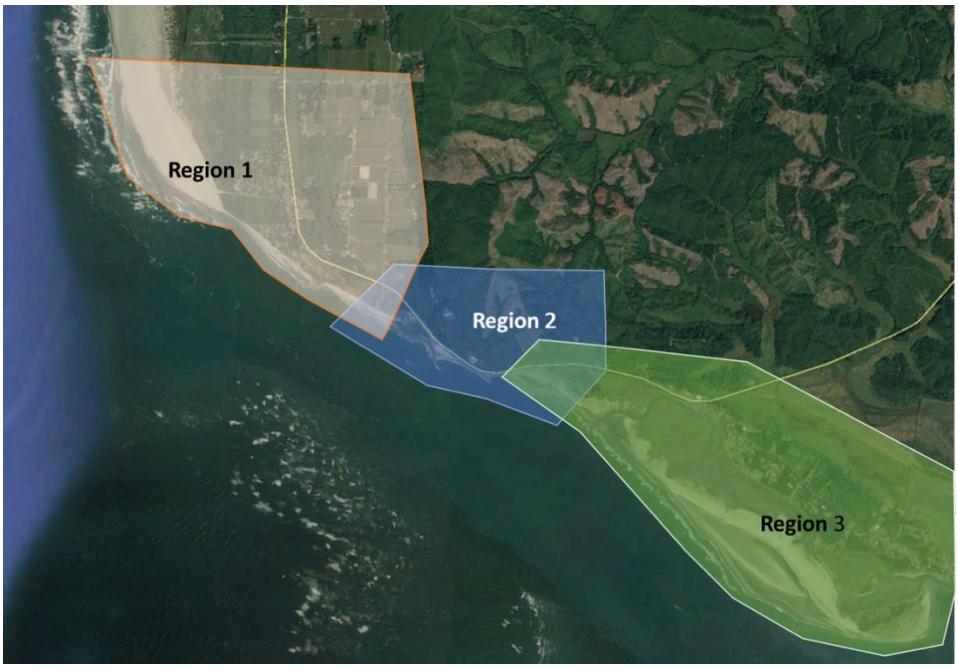
Partners: Private landowners, Washington Department of Ecology, Washington Department of Transportation, U.S. Army Corps of Engineers, Washington Department of Fish & Wildlife, Pacific Conservation District, Washington State Rep. Brian Blake, Pacific County Commissioner Lisa Ayers, Ken Miller Enterprises Inc.

Permits: Hydraulic Project Approval (Washington Department of Fish & Wildlife), Joint Aquatic Resource Permit Application (applies to multiple federal, state and local agencies), 20-year easement with Washington State Parks, permissions from private landowners, and county determination of non-significance.

Funding: $600,000 (Washington State Legislature/Capitol Budget),
~$50,000 (Washington State Conservation Commission),
~$11,000 (Washington State Department of Transportation),
$10,000 (Grayland Cranberry Association),
$10,000 Pacific County Marine Resources Council, and
additional funds from Pacific County Drainage District No.1 and local fundraising (bake sales, shirt sales, etc.).
Many of these funds were aligned with Pacific Conservation District's Shellfish Cost Share Program.

This project was enabled when Charlene Nelson (Tribal Chairperson, Shoalwater Bay Indian Tribe) held a meeting with local parties and agencies. Attendees discussed local erosion issues face-to-face, which was a necessary step in order to coordinate efforts and form lasting partnerships. Prior to this meeting, efforts to address erosion at North Cove had been fragmented and ineffective. Once community members met agency representatives and other project partners, communication lines were established, which eased access to permits, approvals and funds required for the project.

The project is related to adjacent adaptation work by the Washington Department of Transportation (Highway 105, "Region 2" in graphic below) and the Shoalwater Bay Indian Tribe (dune replenishment via the U.S. Army Corps of Engineers, "Region 3" below).



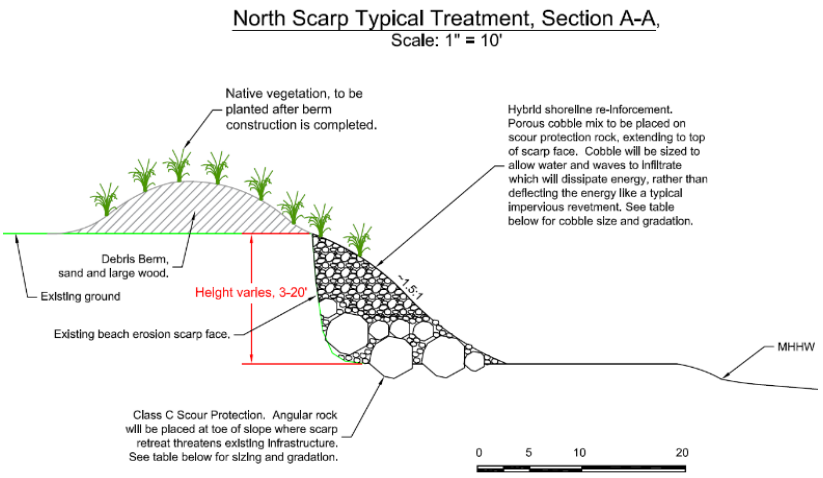
The North Cove shoreline is comprised of three distinct regions, each with differing conditions influencing erosion trends. The North Cove Dynamic Revetment addresses erosion in Region 1 and is coordinated with two other projects working in the adjacent regions. (Image credit: Washington Coastal Hazards Resilience Network)

Description of Work Completed

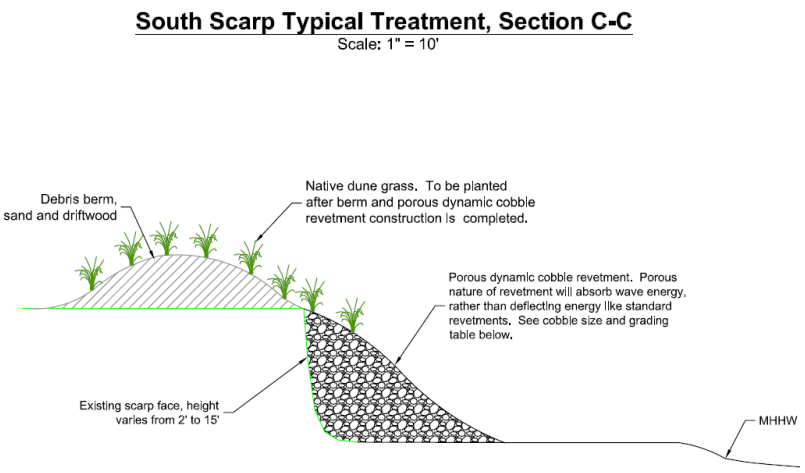
This project consists of multiple strategies aimed at reducing wave impacts while building shoreline material and reinforcing the existing shoreline. These strategies are continually being adapted based on lessons learned, new ideas and changing shoreforms. Natural materials, such as cobble, sand and large wood, provide a porous surface that absorbs wave energy, rather than deflecting it to adjacent areas as typical rip rap or bulkheads do. Up to five feet of sand and wood is placed on low-lying banks to create berms, which reduce overtopping. Native vegetation such as American dune grass (*Leymus mollis*) helps anchor sediments in place.

Wave energy spreads the cobbles onto the beach and away from their initial location. These dispersed cobbles form a protective layer within the tidal zone, reducing erosion. The movement of this material in the nearshore currents is being tracked in order to better understand longshore drift. This knowledge will allow project partners to mechanically place material in strategic locations, so that it becomes naturally distributed to areas of the shoreline where it is needed most.

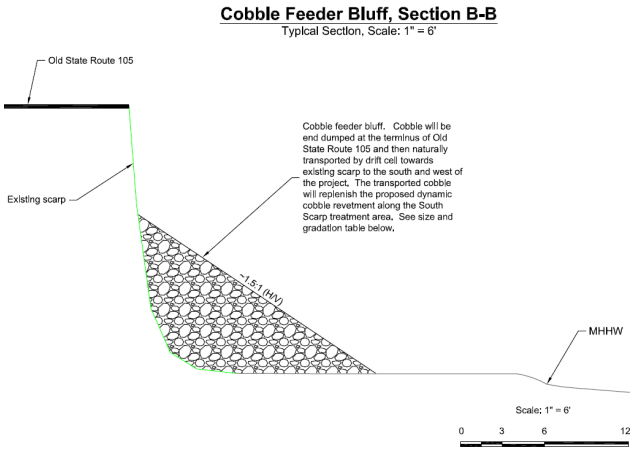
This project's primary approaches are dynamic revetments (cobble, sand, rock) and installation of large woody debris. Below are images of several different projects in place along North Cove's shoreline. Phase 1 (2016) consisted of a limited test of dynamic cobble in a high-energy area. Phase 2 (2017) expanded this test into several vulnerable locations. Phase 3 (2018) connected all tests to form a 1.25-mile protection area with reinforcements and berms in critical zones. For more detail, see Project Downloads, listed at the end of this article.



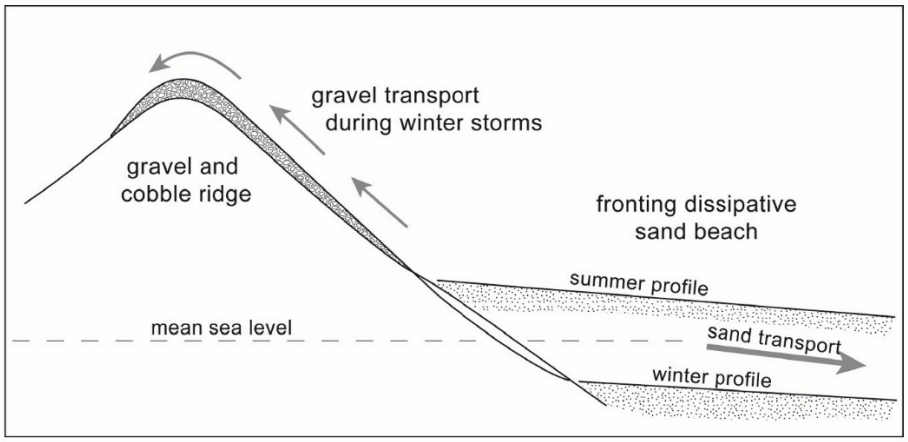
The northern portion of this project addresses erosion along dunes up to 20 feet high (pictured during high tide at left). In order to reduce erosion at the base of the slope, large rocks are placed below cobbles, sand and wood (right).
(Left photo credit: Katrina Radach, The Nature Conservancy; right image credit: Pacific Conservation District)



The southern portion of this project addresses erosion along lower shorelines, using cobble, sand and vegetation.
(Left photo credit: Katrina Radach, The Nature Conservancy; right image credit: Pacific Conservation District)



Constructed cobble feeder bluff (in foreground) feeds beaches (in background) with protective material (left). (Left photo credit: Jackson Blalock, The Nature Conservancy; right image credit: Pacific Conservation District)



During winter storms, sand is carried away from the shore, exposing and moving the revetment's cobble (gravel) substrate as a "winter beach profile." During summer, sand is deposited on the cobble substrate, creating a "summer beach profile." (Image credit*: Paul D. Komar and Jonathan C. Allan, "*Design with Nature" Strategies for Shore Protection*)*

David Cottrell of Washaway No More shows how large wood structures have been anchored into banks and other wood. Placing large wood structures at intervals effectively disrupts the longshore current and helps retain sand, preventing further erosion. (Photo credit: Jackson Blalock, The Nature Conservancy)

Lessons Learned

A key takeaway from this project is to design and build using natural processes as a guide. Several of the community's previous attempts to mitigate erosion sought to create static structures and plans that fought against nature. However, these structures did not last through storms. As project partners experimented, they focused on materials native to the area, such as logs and dune grass. Logs were used to dissipate wave energy, and their movements were noted by project partners. The composite beaches of the Olympic Peninsula and Oregon, where rocks stabilize the upper ends of sandy beaches, informed the use of cobbles in this project.

Since local community members have led much of this work, adaptive management has played a ongoing role in this project. Community members involved in this project regularly witness changes along North Cove's shore. They use these observations to adjust existing erosion control structures and inform future phases of work.

Perhaps one of the greatest contributions to this project's success was the creation of new partnerships between agencies and local communities. These partnerships included: the Willapa Erosion Control Action Now—an ongoing community initiative to protect the shores—and the Willapa Shoreline Erosion Protection Demonstration Project—a long-term planning collaboration funded by the Washington State Legislature. Through collaborations and partnerships, this synergistic project has addressed a large stretch of shoreline with varying sediment dynamics, and where stakeholders have diverse interests. Regular communication between parties has also resulted in more efficient work.

Composite beaches in Oregon are natural forms of shore protection and provided ideas for the dynamic revetment's design. (Photo credit: Jonathan C. Allan)

This document was produced as part of the Washington Coastal Resilience Project, working to increase the state's capacity to prepare for coastal hazards related to sea level rise. The project was led by the Washington State Department of Ecology and Washington Sea Grant, with funding provided by NOAA Regional Coastal Resilience Grants Program (grant #NA16NOS4730015)