Stormwater Action Monitoring

Oyster Shell Retrofits in Catch Basins for Dissolved Metals Treatment

Effectiveness Study

Lead Entity

King County, DNRP

Partners

City of Mercer Island

Port of Seattle

Collectively improving stormwater management

Stormwater Action Monitoring (SAM) is a collaborative, regional stormwater monitoring program that is funded by more than 90 Western Washington cities and counties, the ports of Seattle and Tacoma, and the Washington State Department of Transportation. SAM's goal is to improve stormwater management to reduce pollution, improve water quality, and reduce flooding. We do this by measuring stormwater impacts on the environment and evaluating the effectiveness of stormwater management actions.

Questions about SAM?
See ecology.wa.gov/SAM

Study goals

This study evaluated whether oyster shells retrofitted into stormwater catch basins can decrease dissolved metal and nutrient concentrations and increase hardness to help reduce runoff toxicity.

Stormwater management problem

Previous studies have shown that dissolved metals typically present in urban stormwater – particularly copper and zinc – can be toxic to fish and other aquatic life, even at relatively low concentrations. The toxicity of these metals increases when water hardness levels decrease, and hardness levels in stormwater are often very low. Because of this low hardness level, copper and zinc concentrations in stormwater are frequently above the acute and chronic Water Quality Standard (WQS) level. Stormwater managers are interested in low-cost retrofit opportunities to improve runoff quality and reduce harmful effects of runoff on aquatic organisms in streams and lakes that receive substantial stormwater inputs.

Previous studies showed success of oyster shell retrofits at the parking lot or individual building site scale. This study aimed to test the approach at a larger catch basin scale.

Project findings

This study compared runoff from two catch basins each fitted with two cubic feet of oyster shells filtering stormwater to two catch basins that had no oyster shells. Stormwater was captured from four storms using time-weighted auto samplers and analyzed for metals, nutrients, hardness, and other conventional parameters. Dissolved copper, lead and zinc exceeded WQS in every sample from both treated and untreated catch basin. No apparent differences were found in any measured parameters between influent and effluent samples at either oyster shell-fitted catch basin or the catch basin. As it became apparent that the oyster shell-fitted catch basins were not significantly improving water quality, the study was halted.

The flow rates during the sampled storms in the four study catch basins ranged from 4.5 to 1180 gallons per minute (GPM) with an average flow of 25 GPM through the catch basin.

Previous studies that had reported successful use of oyster and mussel shells as

stormwater treatment media were conducted with larger volumes of shells and a lower volumes of storm water. A previous study using oyster shells to treat metals in roof runoff found success treating 5 to 15 GPM flow through 4.8 cubic feet of oyster shells.

The results of this pilot study indicate that a much larger treatment media volume of oyster shells is necessary to adequately treat the amount of stormwater draining through the Mercer Island stormwater catch basins.

This study also found that finely crushed oyster shells, approximately half-inch pieces, likely contributed to a clogging event that occurred in both catch basins fitted with oyster shells prior to sampling. These were replaced with mostly whole and some lightly broken oyster shells placed in mesh bags, which did not induce clogging during the remainder of the study.

Recommendations

Additional studies will help project proponents and stormwater managers understand how to scale up the previously successful ratio of approximately 1-3 GPM of runoff through each cubic foot of oyster shell treatment retrofit, and what is the upper recommended limit of area that can or should be treated with this approach. For this study, approximately 12.5 GMP through 1 cubic foot of shells was too much flow and not successful.

Retrofitting of existing stormwater infrastructure with oyster shells to improve stormwater quality may potentially still be successful with a greater treatment-media-volume to stormwater-flow ratio that provides sufficient treatment/contact time. The study results indicate that lightly crushed (i.e., larger pieces) oyster shells worked best to prevent clogging of stormwater catch basins during rain events. Hydraulic analysis of the stormwater infrastructure to be retrofitted will help better understand the treatment-media-volume to stormwater-flow ratio needed to be successful. The Port of Seattle has found success with retrofitted catch basins in a smaller drainage area (i.e., parking lot) and oyster shells in rain barrels treating roof runoff (https://www.portseattle.org/sites/default/files/2023-04/2023-0307_Final_Oyster_Handout.pdf).

The study also aimed to determine whether this non-proprietary technology should be evaluated through the Technology Assessment Protocol – Ecology (TAPE) program dissolved metals treatment.

Why does this study matter?

We want to increase opportunities for affordable retrofits that provide stormwater treatment benefits for local lakes, streams, and Puget Sound, especially from areas without existing stormwater treatment. This oyster shell retrofit design requires minimal construction and causes no impacts to above-ground areas. With the right treatment-media-volume to stormwater-flow ratio, this type of retrofit could provide a relatively inexpensive, low maintenance treatment for dissolved metals removal.

What will Ecology do with this information?

Ecology should continue to allow oyster shell retrofits to treat small areas. Ecology can use the findings from this study to design studies to help us further understand how to successfully design and implement oyster shell retrofits to improve stormwater quality. Such studies should result in provisional design and maintenance criteria for scaled-up application of oyster shell retrofits.

What should we do with this information?

Stormwater managers should allow oyster shell retrofits to treat runoff from a small parking lot or building roofs, particularly where land uses are likely to produce metals in the runoff. Shells should not be finely crushed, or clogging may result. Ensure that the project proponents choose a suitable site for installing oyster shell retrofits and an adequate treatment-media-volume to stormwater-flow ratio; (e.g. 1ft3 broken shell to 1-3 GPM). These retrofits might be a key step in a treatment train.

For more information

Visit the SAM website at www.ecology.wa.gov/SAM and search for the completed oyster shell study on the Effectiveness Studies page.