Pooled Monitoring Initiative's Restoration Research Award Program

Project Title

Comparative analysis of Maryland highway mini-catchments to assess the effective-ness of bioretention in addressing storm-water impacts

Lead Entity

University of Maryland Center for Environmental Science, Appalachian Laboratory

Partners

MDOT-State Highway Administration

The Pooled Monitoring Initiative pools resources to support scientists who answer key restoration questions posed by the regulatory and practitioner communities. The research teams then provide the answers back to those who asked the questions for direct application. The goal of the program is to answer these key restoration questions that serve as a barrier to watershed restoration project implementation.

Questions? See cbtrust.org/grants/restoration-research/

Research question(s)

A. Effectiveness of stormwater and stream restoration programs at the watershed/catchment scale: 1. BMP effectiveness monitoring. B. Effectiveness of restoration practices at the project scale: 4. Climate change impacts to restoration practice.

Issues addressed

- Performance of bioswales in controlling stormwater runoff and stormwater pollution associated with Maryland's highway system
- Bioswale performance was assessed relative to grassed swales with which the bioswales were paired at three sites across the state in a long-term study.

Project findings

- Underdrainage was the dominant form of runoff from the bioswales, contributing 87 - 94% of total runoff over the course of the multi-year study.
- Extremely high (95 – 100%) percentages of the rainfall was "captured and treated" by the bioswales, primarily due to extremely high infiltration capacity of the engineered biosoil media and the unregulated underdrains.

Award # 20588

Pooled Monitoring Initiative's Restoration Research Award Program

Project Title

Comparative analysis of Maryland highway mini-catchments to assess the effective-ness of bioretention in addressing storm-water impacts

Lead Entity

University of Maryland Center for Environmental Science, Appalachian Laboratory

The Pooled Monitoring Initiative pools resources to support scientists who answer key restoration questions posed by the regulatory and practitioner communities. The research teams then provide the answers back to those who asked the questions for direct application. The goal of the program is to answer these key restoration questions that serve as a barrier to watershed restoration project implementation.

Questions? See cbtrust.org/grants/restoration-research/

- The study provided little evidence of "extra" retention of stormwater over what the grassed swales provided. Mean storm runoff volume was significantly reduced at only one bioswale which was attributed to percolation and local groundwater recharge.
- Differences in peak runoff could be mostly explained by differences in rainfall intensity between the swales—thus demonstrating little attenuation due to the presence of the bioretention cells and underscoring their "hyper-efficiency" at translating overland runoff into underdrainage and sensitivity to future hydroclimatic changes.
- While no differences in total suspended solids (TSS) loads were observed, mean ortho-phosphate-P event loads were significantly lower (by 40 - 80%) at the three best-studied bioswales—providing strong evidence of P-chemisorption.
- Conversely, mean event nitrate-N loads from the same three bioswales were significantly higher (by 190 – 790%) than loads from the corresponding grassed swale controls, pointing to the bioretention cells as providing a major source of nitrate-N.

Award # 20588

Project Title

Comparative analysis of Maryland highway mini-catchments to assess the effectiveness of bioretention in addressing stormwater impacts

Lead Entity

University of Maryland Center for Environmental Science, Appalachian Laboratory

The Pooled Monitoring Initiative pools resources to support scientists who answer key restoration questions posed by the regulatory and practitioner communities. The research teams then provide the answers back to those who asked the questions for direct application. The goal of the program is to answer these key restoration questions that serve as a barrier to watershed restoration project implementation.

Questions? See cbtrust.org/grants/restoration-research/

Recommendations

- The hydraulic performance of the bioswales should be maintained so that stormwater can continue to infiltrate and percolate through the bioretention cells—thus allowing for continued P-sorption.
- For the future, designers should consider modifying the hydraulic properties of the biosoil and/or expanding the footprint of the bioswales to promote greater transient storage and retention, especially under future climate scenarios with greater rainfall volumes and higher rain intensity.
- The use of other materials (e.g., biochar) or additives to biosoil to address specific stormwater pollutants is an area of active research and should probably be considered for future bioswale designs.
- As others have proposed, using bioswale technology to address N pollution will require a significant redesign that 1) allows for the presence of aboveground vegetation year-round and 2) promotes the formation of a zone of transient water storage/saturation to support microbial denitrification.

Pooled Monitoring Initiative's Restoration Research Award Program

Project Title

Comparative analysis of Maryland highway mini-catchments to assess the effectiveness of bioretention in addressing stormwater impacts

Lead Entity

University of Maryland Center for Environmental Science, Appalachian Laboratory

The Pooled Monitoring Initiative pools resources to support scientists who answer key restoration questions posed by the regulatory and practitioner communities. The research teams then provide the answers back to those who asked the questions for direct application. The goal of the program is to answer these key restoration questions that serve as a barrier to watershed restoration project implementation.

Questions? See cbtrust.org/grants/restoration-research/

Why does this study matter?

Replicated field studies of the relative performance of highway swales operating under real-world hydro-climatological conditions across multiple years are relatively uncommon. Importantly, P reductions by the bioswales were shown to exceed 50% (in some cases 75%) which is consistent with proposed MEP (maximum extent practicable) goals for this type of stormwater best management practice (BMP), but their effectiveness at reducing N runoff is much less.

What should we do with this information?

Following publication of the results in the scientific and engineering literature, the results should be clearly communicated and translated to the regulatory community and practitioners who are responsible for crediting existing activities and BMPs and in approving future designs.

What will the end-user (regulator/manager and practitioner) do with this information?

Regulators, water quality managers, and stormwater professionals should carefully consider the relatively modest differences in hydrologic responsiveness

Pooled Monitoring Initiative's Restoration Research Award Program

Project Title

Comparative analysis of Maryland highway mini-catchments to assess the effectiveness of bioretention in addressing stormwater impacts

Lead Entity

University of Maryland Center for Environmental Science, Appalachian Laboratory

between the bioswales and the legacy grassed swales that were monitored, as well as differences in the relative effectiveness of these BMPs in controlling P and N pollution. In watersheds where the primary goal is to reduce P loads, bioswales would be the preferred BMP; in watersheds where N load reduction is more important, leaving legacy grassed swales in place is the preferred option in the short-term. In the long term, regulators should incentivize bioswale redesign to more effectively address stormwater impacts from highways in Maryland and elsewhere.

For more information:

Please contact Keith Eshleman (301-689-7170; keshleman@umces.edu).

The Pooled Monitoring Initiative pools resources to support scientists who answer key restoration questions posed by the regulatory and practitioner communities. The research teams then provide the answers back to those who asked the questions for direct application. The goal of the program is to answer these key restoration questions that serve as a barrier to watershed restoration project implementation.

Questions? See cbtrust.org/grants/restoration-research/