Measuring Individual Tree Water-use in Mature Native Species in the Pacific Northwest to Determine their Benefits for Stormwater

Stormwater Action Monitoring

Effectiveness Study

Lead Entities

Partners

Highlights:

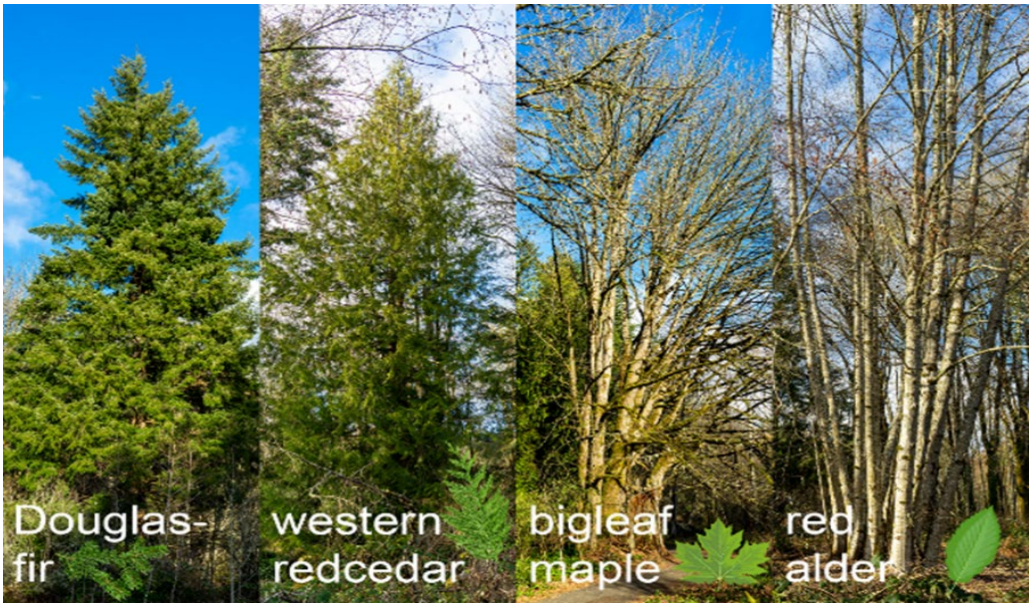
- Evergreen and deciduous trees captured or slowed stormwater by intercepting and transpiring 44-65% of rainfall.
- Evergreen trees provide more hydrologic benefits for stormwater management than deciduous trees.

Study goals related to stormwater managment

Using existing trees to manage stormwater in urban areas, particularly rapidly growing communities in western Washington is of great local interest. Low Impact Development (LID) includes guidance to leave mature trees in place when developing properties to manage rainfall and runoff as well as providing other co-benefits such as green space and shade. Stormwater managers need information on the relative benefit provided by individual trees as stormwater best management practices (BMPs).

The purpose of this project was to quantify how much rain and runoff is captured by mature common native evergreen and deciduous trees based on actual climatic conditions of the Pacific Northwest.

Instruments were installed at 64 trees in two locations around the Olympia area to determine transpiration rates of four species: Douglas-fir, western red cedar, big leaf maple, and red alder. All 64 trees had instruments to measure sap flux, 36 measured canopy interception, and 24 measured stemflow.



Project findings

A total of 184 qualified storm events were monitored; 116 events occurred during leaf-off and 68 occurred during leaf-on seasons.The total tree hydrologic budget was

Stormwater Action Monitoring (SAM) is a collaborative, regional stormwater monitoring program that is funded by morethan 90 Western Washington cities and counties, the ports of Seattle and Tacoma, and theWashington State Departmentof Transportation.

SAM's goal is to improve stormwater management by measuring stormwater impacts on the environment and evaluating the effectiveness of stormwater management actions.

calculated from the two years of data as the fraction of rainfall captured by transpiration and interception. Rainfall data was segmented into discrete storm events as defined by Ecology criteria.

Table 1. Water budgets: rainfall and median values for transpiration plus interception by tree species

Season	Leaf-Off (Nov-April)		Leaf-On (May-Oct)	
Qualifying Storm Totals (cm)	124.8		42.9	
	Median transpiration + interception of qualified storms by tree species			
Tree Species	%	cm	%	cm
Big leaf maple	27.6	34.4	126.5*	54.3
Red alder	30.6	38.2	76.2	32.7
Douglas-fir	57.2	71.4	73.1	31.3
Western red cedar	63.3	79.0	72.6	31.1

* The big leaf maples intercepted and transpired more than the total volume of water incident on their canopies (126.5%) during the leaf-on season. Extra water was likely drawn by the roots from the soil.

All four species intercepted and transpired over 40% of the rainfall landing on their canopies on an annual basis, meaning this rainfall did not become runoff. Differences between trees were most evident in the leaf-off season (winter through spring) when the stormwater management needs are highest. During the leaf-off season the evergreen trees (which keep leaves year-round) continue to transpire and intercept rainfall on their canopies. Where as deciduous trees can only intercept on their branches, and are mostly dormant (not transpiring) for much of this timeframe. Overall these mature tree species managed 44-65% of annual rainfall through interception and evapotranspiration.

Recommendations

We recommend mature tree retention and tree planting in urban settings to the extent feasible, and use of more evergreen trees when possible for stormwater management in the wetter months.

Why does this study matter?

This study gathered high quality water budgets on individual mature native trees in Washington State. We compared these findings to the 'tree credits' offered in the Ecology Stormwater Management Manuals (SWMMs) under BMP T5.16 (WWA) and BMP F6.62 (EWA). Per BMP T5.16/F6.62, if trees are retained on site and meet certain requirements (e.g proximity to an impervious surface), the 'tree credits' allow the designer to reduce the amount of impervious surface entered into the model. This impervious surface reduction will mimic the reduced runoff flow that the retained tree(s) will cause, compared to runoff flow from the full amount of impervious surface(s) without nearby retained tree(s). Our comparison showed no changes are needed to the 'tree credits' under this BMP.

What should stormwater managers do with this information?

Stormwater designs may be able to reduce the size of Flow Control BMPs if they retain mature trees and apply 'tree credits' per SWMM BMP T5.16/F6.62. This LID strategy can be used to encourage preserving mature trees in areas for stormwater mitigation, which will also result in multiple co-benefits. Evergreen trees provide distinct advantages for winter and spring hydrology, but the most appropriate tree for the site should be planted.

What will Ecology do with this information?

We confirmed that the appropriate amount of 'tree credits' are allowed per BMP T5.16/F6.62. Ecology will add a reference to this study in BMP T5.16/F6.62, as supporting documentation for the BMP design guidance. Further, Ecology looks forward to the second phase of this study on the same species as new tree plantings.

For more information see the completed Effectiveness Study at ecology.wa.gov/SAM. The study was overseen by Abby Barnes (WA State Department of Natural Resources), led by Dr. Ani Jayakaran (Washington Stormwater Center) and co-led by Dr. Dylan Fischer (Evergreen State College).