Tree Canopy Land Uses and Pollution Benefits

Urban Stormwater Workgroup

September 15, 2015

Chesapeake Bay Program

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DECISIONS for TODAY

- Does USWG support the TC land uses?
- Does USWG support the Technical Memo produced by the Expert Panel?

BACKGROUND

- Tree Canopy approved as Land Use in October 2014 pending recommendations on loading.
- Fits the definition of a Land Use:
  1) can be mapped;
  2) has loading rates specific to that land use;
  3) has distinct best management practices that apply to that land use (Tree Canopy programs at the state level).
- March & April 2015—Loading paper submitted to Modeling WG from FWG. Proposed Tree Canopy loading rates to modify the understory and be assigned a unique loading as distinct as the land uses they modify.
- April 2015—Land Use WG presents to Modeling Team, FWG, and others that Tree Canopy over Pervious and Tree Canopy over Impervious are being mapped separately.

Tree Canopy Land Uses

- The three different land uses for Tree Canopy are: 1) **TCI** (Tree Canopy over Impervious*)*, 2) **TCT** (Tree Canopy over Turf grass), and 3) **TCO** (Tree Canopy over Open Space)
  - Third land use was required because it impacted the "Natural" group.
  - Recommend that TCI reductions be applied to Roads as the majority will be over roads, not buildings.
- All three of these Phase 6 tree canopy land uses were coded into Scenario Builder in preparation for the October 1st calibration.
- Recommendation on loading rates from the Urban Tree Canopy Expert Panel presented by Neely Law, Chair

BENEFITS of HAVING A COMPLETE ACCOUNTING OF ALL TREES IN PHASE 6

1) Land use changes are a significant input for the Watershed Model. Water quality benefits of urban tree canopy have been recognized since 2003, but CB Model has not directly accounted for these benefits.
2) This information at the watershed scale helps with verification and knowing whether localities are on track with their goals.
3) Tree Canopy should be part of all model scenarios, including No Action. Treating natural landscape features through NEIEN would be confusing and cumbersome for the CBP Partners.
4) If tree canopy over impervious is not mapped, loads from impervious cover will be overestimated.
5) Tree Canopy Land Uses in Phase 6 will ensure that the data is consistent and informs the Tree Canopy Outcome in the 2014 Bay Agreement.

RELATED ISSUES

- FWG would like TC land uses updated when new watershed wide land use data is available.
- FWG currently recommends that new acres of Tree Canopy continue to be annually reported for WIP credit.
- FWG expects to review these and other issues when Expert Panel delivers their final report later this year and the USWG should plan to do so also.

Chesapeake Bay Program Expert Panel Proposed Method to Estimate Water Quality Benefits of Tree Canopy as a Land Use

Recommendations from the Urban Tree Canopy Expert Panel on Loading Rates for Tree Canopy Land Uses

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Definitions

- **Tree canopy** as classified by the CBP, includes all areas covered by tree canopy that do not fall under the forest land use definition. Can include individual trees, groups of trees, remnant patches with a circular radius less than 120 feet. The water quality benefits of tree canopy that is forest or a riparian buffer are accounted for in the model

- **Runoff reduction** is defined as the relative difference in runoff volume from an area with tree canopy compared to runoff volume from the same area without tree canopy

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Review of the Science

- A total of 73 publications were reviewed by the Expert
- Majority focused on hydrologic benefits
  - Interception
  - Evapotranspiration
  - Infiltration
  - Runoff Reduction
- Limited information on water quality and urban tree canopy

INTERCEPTION value--
Based on 24 Studies of Urban Forests

Table 1. Rainfall Interception Studies of Urban Trees

Study	Location	Interception (% of annual rainfall)[1]	Species/Condition[2]	Type of Study
Wang et al. 2008	Baltimore, MD	18.4	Tree canopy in Dead Run subwatershed	Modeling
Band et al. n.d.	MidAtlantic	Accotink 14.5% Gwynns Falls: 15.7% Rock Creek 19.6%		Modeling
Xiao et al. 1998	Sacramento County, CA	11.1	Tree canopy in the County	Modeling
Xiao et al. 2000	Davis, CA	15 27	Pear (D) Oak (E)	Measured
Xiao and McPherson	Oakland, CA	14.3 25.2	Sweetgum (D) Gingko (D)	Measured

- *Emphasis on key studies in Mid Atlantic – 17% average*

Assumptions

- Pollutant loads will be reduced proportional to reduction in annual runoff volume
- It is recognized that individual storm events (precipitation, seasonality) along with other site specific and tree characteristics, will have an effect on runoff production. Focus on studies with annual time step

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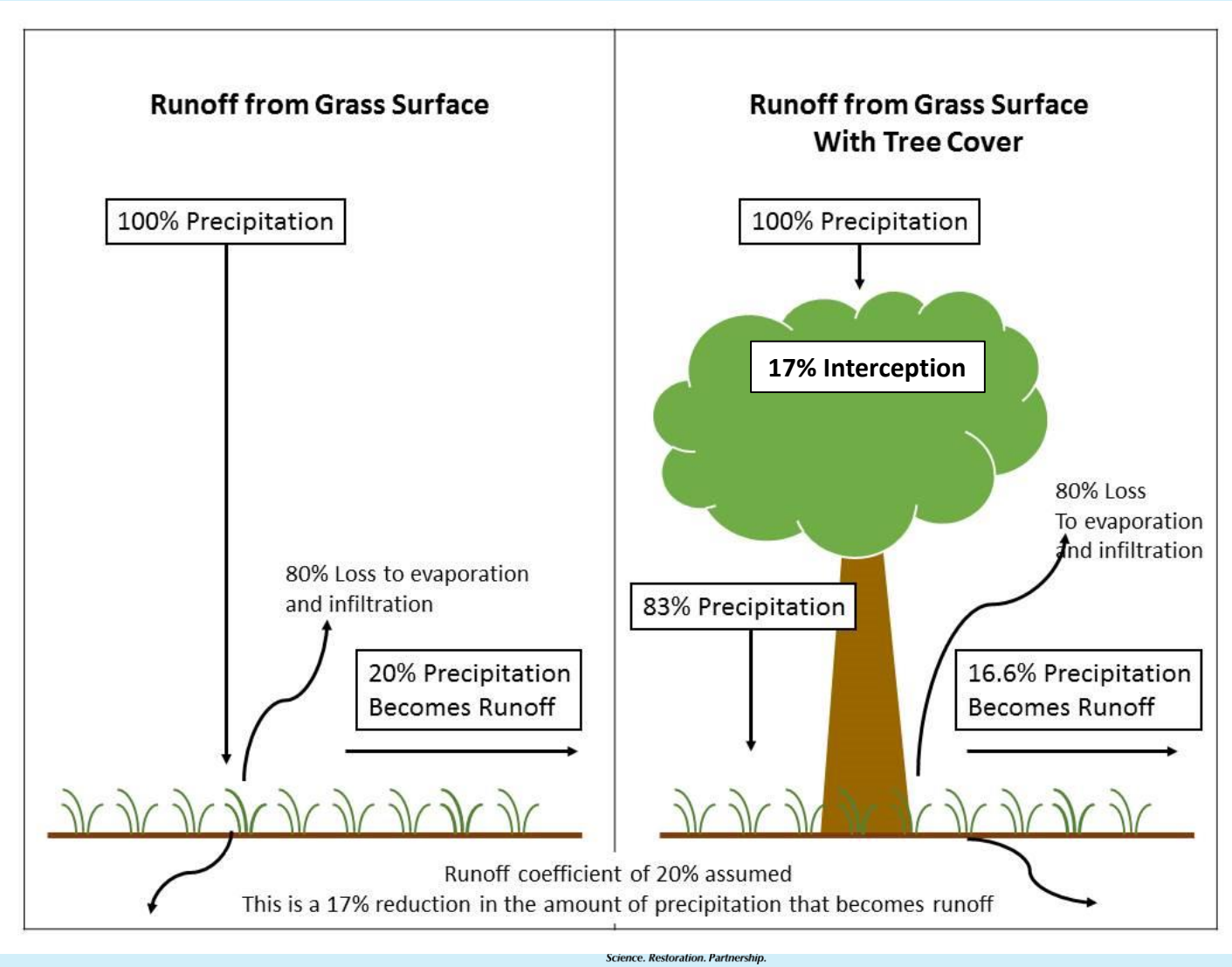
METHOD: Compare the runoff reduction with and without using a simple mass balance approach for a site



Method and graphic modified from Herrera (2008)

Calculation of relative loading rate for tree canopy of pervious and tree canopy over impervious

Runoff reduction % = (runoff reduced/ site runoff without tree canopy) * 100

Tree Canopy over Pervious		Tree Canopy over Impervious	
Runoff reduced in inches = 1.4 inches		Runoff reduced in inches = 6.8 inches	
Site runoff without tree canopy	Site runoff with canopy	Site runoff without tree canopy	Site runoff with canopy
8.4	7	39.9	33.1
Runoff reduction % = 16.6		Runoff reduction % = 17.0	
Runoff reduced	Site runoff without tree canopy	Runoff reduced	Site runoff without tree canopy
1.4	8.4	6.8	39.9

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What about transpiration?

- Chesapeake Bay model accounts for both surface runoff and interflow as part of streamflow
- Need to account for how interflow affects relative loading rate
- Assume TP and TSS would not be affected by interflow, only soluble fraction of TN (~30%)
- Assume 5% transpiration is the amount of water uptake by trees (relative to total rainfall), reducing interflow by the same amount
- Using our example
  - 5% of rainfall, or 0.05 x 42 inches = 2.1 inches
  - Interflow only affect soluble TN, which is 30%
  - 30% of 2.1 inches = 0.63 inches
- Tree canopy further reduction of 0.63 inches or 1.5% of runoff reduced for TN, only

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Recommendation for relative loading rate for tree canopy land use

Same relative loading rate of 17% for both Tree Canopy land uses, 'bump up' for TN due to additional reduction from interflow

- TP and TS = 17%
- TN = 18.5%

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Developed Land Uses As Currently Mapped

LoadSource	LoadSourceMinor	CB wide Acreage
Roads	Impervious	598,864
Buildings and Other	Impervious	916,623
Turf Grass	Pervious	3,626,082
Tree Canopy over Impervious	Impervious	141,986
Tree Canopy over Turf Grass	Pervious	793,817

Developed Land Ratios and Areas

LoadSource	Acreage	TN	TP	TSS
Roads	598,864	1	1	1
Buildings and Other	916,623	0.786	0.794	0.578
Turf Grass	3,626,082	0.479	1.000	0.069
Tree Canopy over Impervious (18.5%N, 17% P, 17% S reduced from Roads)	141,986	0.815	0.83	0.83
Tree Canopy over Turf Grass (18.5%N, 17%P, 17% S reduced from Turf Grass)	793,817	0.390	0.83	0.057

Bottom Line

- Trees are excellent for water quality; TC land uses account for existing tree canopy.
- We can tell partners whether Tree Canopy is growing or shrinking.
- This is information jurisdictions need to manage impacts of land use change on water quality.

QUESTIONS?

DECISIONS

- Does USWG support the TC land uses?
- Does USWG support the Technical Memo produced by the Expert Panel?

Tree Canopy over Impervious Surfaces (TCI)

a. Small or narrow patches of trees (or the edges of forests for areas mapped with regional land use data) that cover all types of impervious surfaces, e.g., street trees.
b. Located within developed areas: residential, commercial, industrial, institutional, and recreational areas and proximal to rural buildings and other structures.
c. Understory dominated by roads.
d. Nutrient and Sediment Loads = some fraction of loads for “Impervious-Roads” land use.
e. Included in the “Developed” macro land use class.

Tree Canopy over Turf Grass (TCT)

a. Small or narrow patches of trees (or the edges of forests for areas mapped with regional land use data) with an herbaceous understory, e.g., turf grass and landscaped areas.
b. Located within developed areas: residential, commercial, industrial, institutional, and recreational areas and proximal to rural buildings and other structures.
c. Understory dominated by turf grass.
d. Nutrient and sediment loads = some fraction of loads for “Turf Grass” land use.
e. Included in the “Developed” macro land use class.

Tree Canopy over Open Space (TCO)

a. Small or narrow patches of trees (or the edges of forests for areas mapped with regional land use data) with a scrub-shrub or unfertilized herbaceous understory, e.g., wind breaks, trees in the median of divided highways, narrow riparian buffers, and trees in pasture/cropland.
b. Located in rural areas that are largely agricultural.
c. Understory dominated by either scrub-shrub or herbaceous vegetation.
d. Nutrient and sediment loads = some fraction of loads for “Open Space” land use.
e. Included in the “Natural” macro land use class.