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Center for Watershed Protection

Chesapeake Bay Program
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Recommendations for the Expert Panel to Define BMP Effectiveness for Urban Tree Canopy

Summary of Recommendations to the Forestry Work Group

May 4, 2016

Panel Scope

- Recommendations for Phase 6 CBWM only
- Convened at request of FWG to determine nutrient and sediment reductions for expanded urban tree canopy
- Review of existing urban tree planting credit
- Literature review
- * Provide input on the development of land use loading rates for tree canopy land uses

Panel Membership

Name	Affiliation
Panel Members	
Karen Cappiella	Center for Watershed Protection
Sally Claggett	US Forest Service, CBPO
Keith Cline	Fairfax County (VA)
Susan Day*	Virginia Tech
Michael Galvin	SavATree
Peter MacDonagh	Kestrel Design Group
Jessica Sanders	Casey Trees
Thomas Whitlow	Cornell University
Qingfu Xiao	University of California–Davis
Panel Support	
Neely Law (Chair)	Center for Watershed Protection
Jeremy Hanson (Coordinator)	Virginia Tech, CBPO
Brian Benham	Virginia Tech (Project Director)
Marcia Fox	DE DNREC (WTWG rep)
Ken Hendrickson	EPA Region 3 (Regulatory Support)
Jeff Sweeney	EPA, CBPO (CBP modeling team rep)

P6 Land Uses as defined by CBP

Forest Land Use

- Minimum canopy area of 9m^2 and minimum height of 5m
- Forests include contiguous patches of trees that are greater than or equal to 1-acre, corresponding to a patch of trees with a minimum internal radius of 36m
- Generally 20m – 30m away from non-road impervious surfaces (e.g., structures, driveways, and parking lots) in developed areas and ~ 10m away from non-road impervious surfaces in rural areas.

Tree Canopy Land Use

- Minimum canopy area of 9m^2 and minimum height of 5m
- Two subclasses: i) tree canopy over impervious; and ii) tree canopy over turfgrass.
- Trees are included in one of these two classes if they overtop roads, driveways, or parking lots or if they are within 20m – 30m of non-road impervious surfaces in developed areas or within 10m of non-road impervious surfaces in rural areas.
- The two tree canopy land uses include the majority of trees located in developed areas and all trees adjacent to rural structures.

Table 2. Preliminary estimates of tree canopy land uses acreage in the Phase 6 CBWM (Beta 1 vers.)

Land Use	CSS (ac)	MS4 (ac)	Non-Regulated (ac)	Total (ac)	% Tree Land use of Developed Land uses
Tree Canopy Over Impervious	732	50,589	102,679	154,000	3
Tree Canopy Over Turfgrass	14,051	383,829	344,748	742,628	14

Urban tree canopy BMP

- Actions and/or program elements that result in expanded tree canopy through the maintenance of existing tree canopy and, or an increase in trees in the urban landscape.
- Urban tree planting only.
- Tree conservation practices that expand existing tree canopy were not considered by the panel under this BMP, but may be considered by a future expert panel.
- Tree canopy that is not available for credit as part of this BMP include forest buffers and trees that are planted as part of a structural BMP (e.g. bioretention, tree bioretention/planter). This BMP will only apply starting with Phase 6 of the CBWM, replacing the Phase 5.3.2 BMP for Tree Planting (Urban).

Expanded tree canopy

- Defined by FWG BMP Verification Guidance as the overall percent of tree cover in a geographically defined locality on developed land.

BMP Performance Measure

- Credit as a land use change given new tree canopy land uses
- Load reduction based on the relative land use loading rate for the tree canopy land use (TC over impervious or TC over pervious)
- Cumulative credit

UTC BMP Credit

Requires two pieces of information

1) N, P and S reduction
2) Area of tree canopy associated with tree planted

Estimated Lbs reduced/yr
= Tree Canopy Acreage of Trees Planted X
% loading rate of TC land use X underlying TC land use loading rate

Water Quality Benefits of Urban Tree Canopy

- Literature Review and Synthesis
  - Section 4; Appendix C
- Relative Reductions in Non-Point Source Pollution Loads by Urban Trees (Appendix B)
  - Approved by WQ GIT, March 2016

Literature Review & Synthesis

- Focus on hydrologic benefits
  - Interception, Evapotranspiration, Infiltration, Runoff Reduction
- Water Quality
  - Runoff
  - Leaf Litter
- Additional Benefits
  - E.g., air quality, habitat, urban heat island

Relative Reductions in Non-Point Source Pollution Loads by Urban Trees

- Work completed by J. Hynicka and M. Divers
- Water balance modeling approach

Table 8. Tree canopy relative land use loading rates based on the underlying land use land cover (Source: Hynicka and Divers 2016)

Land Use	Total Nitrogen Reduction (%)	Total Phosphorus Reduction (%)	Total Sediment Reduction (%)
Canopy over Turfgrass	23.8	23.8	5.8
Canopy over Impervious	8.5	11.0	7.0

UTC BMP Credit

Estimated Lbs reduced/yr
= Tree Canopy Acreage from Number of Trees Planted X
% loading rate of underlying TC land use X underlying TC land use loading rate

Requires two pieces of information

1) N, P and S reduction
2) Area of tree canopy associated with tree planted

Review of Current Credit

- Urban Tree Planting Credit
  - Land use change from pervious to forested land use
  - 100 trees planted equivalent to 1-acre forested land use
- Lacking documentation & too generous
- Need a credit method more representative of urban planting and growing conditions
- "Every tree Counts"

Modeling Approach

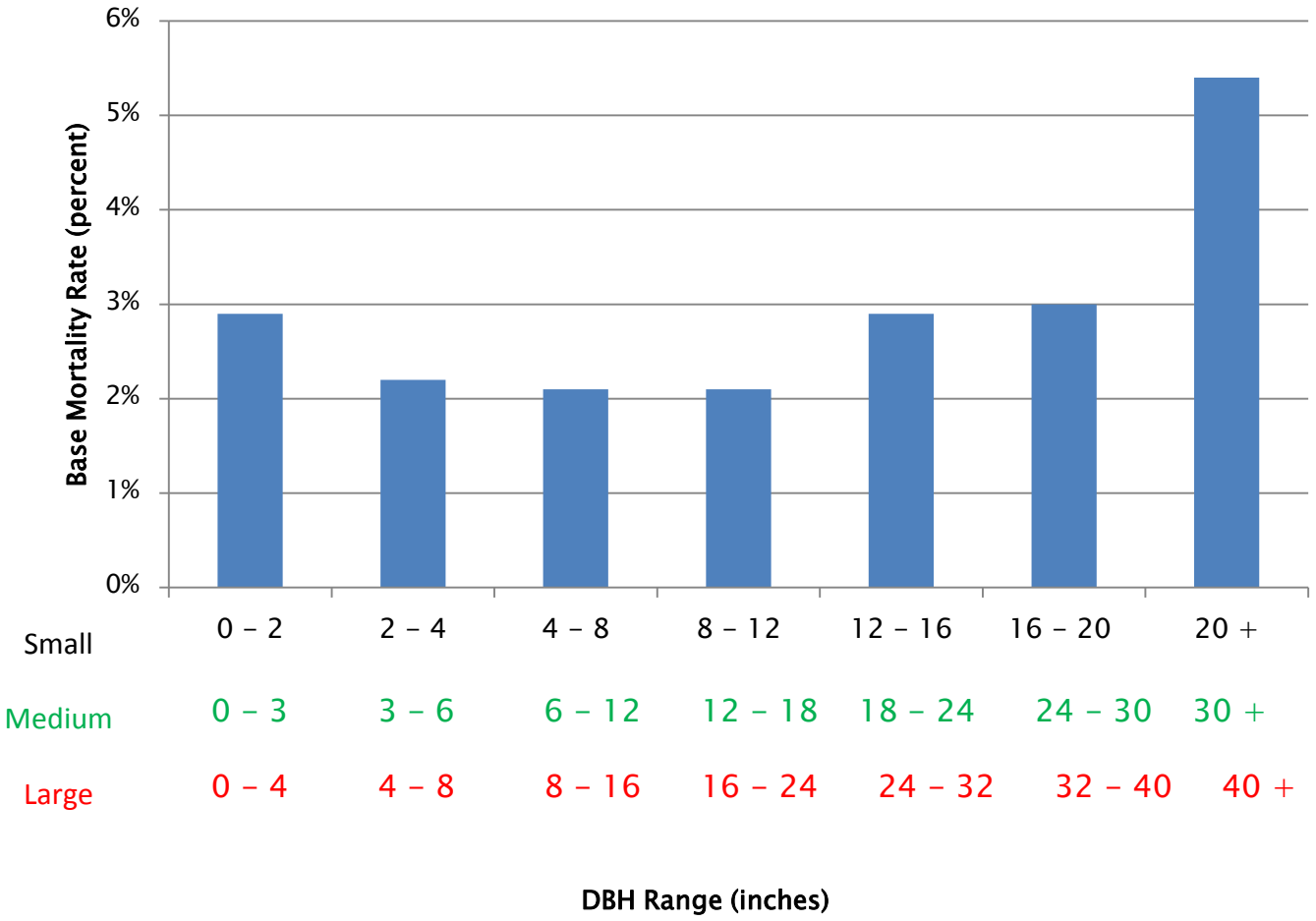
"What is the average annual canopy for every tree planted?"

- Use of i-Tree Forecast to estimate average annual canopy area and growth
- Canopy cover predicted based on tree species (growth rate, height at maturity), DBH, light exposure and dieback

i-Tree Forecast:
Tree Growth & Mortality

- **Light exposure**: forest-growth, park, open-grown
- **Tree condition** based on crown dieback where greater crown dieback, higher mortality
- Trees in fair to excellent condition, crown dieback has limited effect on diameter growth rates
- **Growth rates** reduced as trees reach max height

Base Mortality Rate by DBH Range for each size class

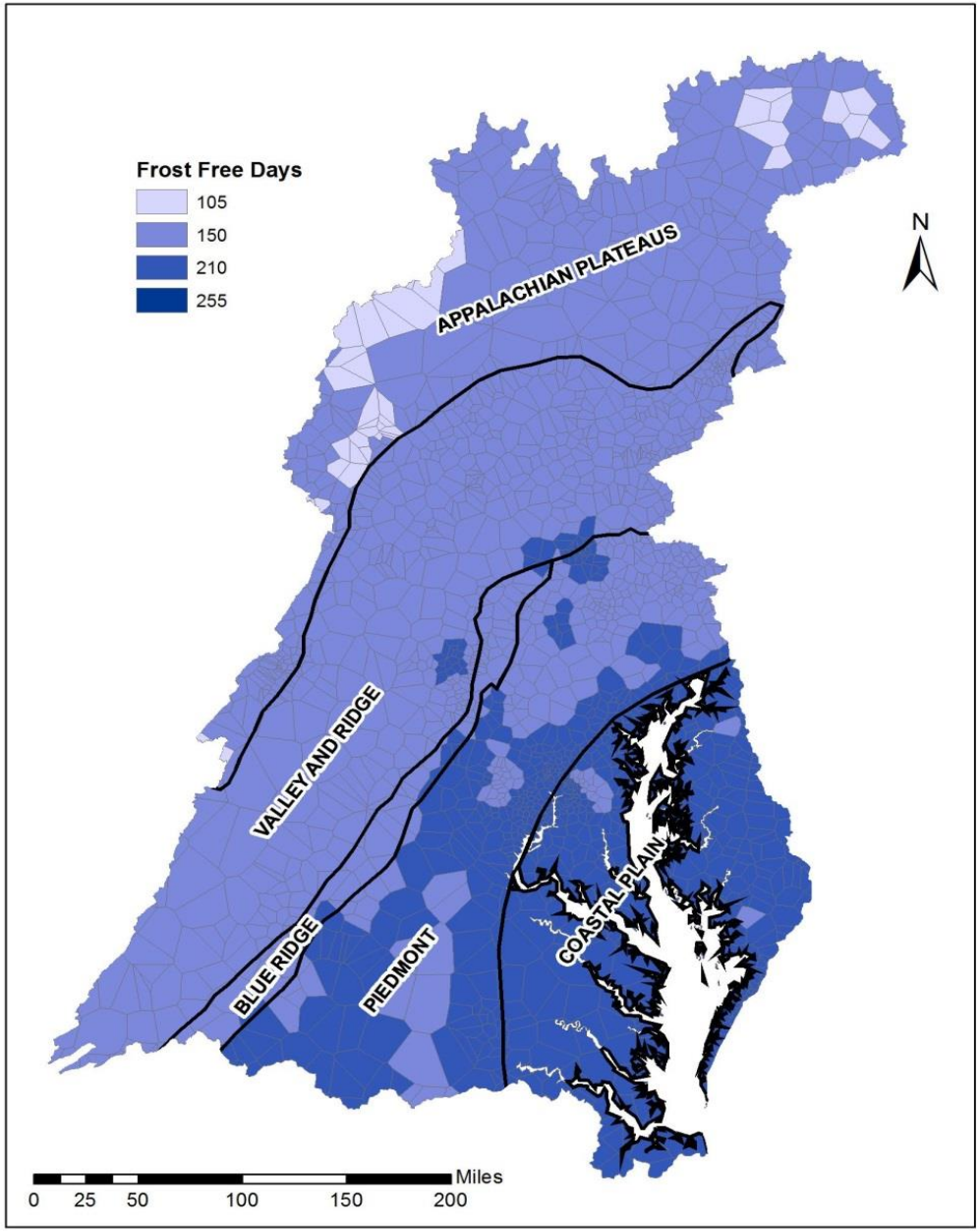


From Nowak et al 2103

- Model scenarios based on Expert Panel input
  - 4 climate areas + 1 Baywide average
  - 1" DBH at planting
  - Tree in good condition at planting
  - 20 tree species
  - 2.5% and 5% mortality
  - Crown light exposure (park-like and open space type conditions)

Climate Regions in the i-Tree Forecast Simulations

- Climate region is defined as the number of "frost-free days" (i.e., length of the growth season)



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- Simulated 10,000 per cohort
- Simulations included 40 cohorts per climate region
  - A cohort is defined as a group of trees which all have the exact same set of input parameters.
  - 20 species, 2 crown light exposure conditions) for analysis and includes approximately 10,000 trees per cohort.
- Canopy area per tree planted is given by:

(Canopy area per surviving tree) x (Number of surviving trees) / (Number of trees originally planted)

Example Output for Broadleaf Tree Species Modeled

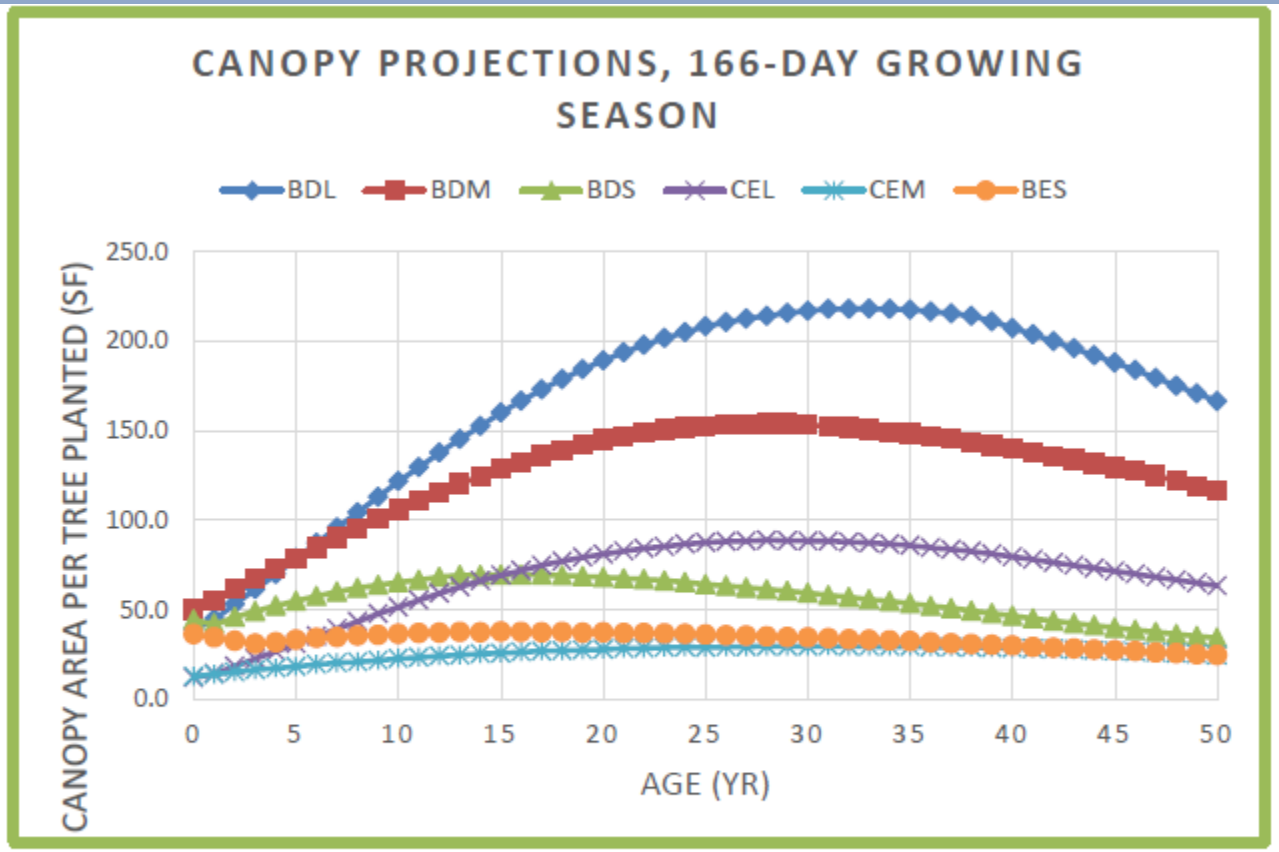


Figure 4. Canopy projections for the Chesapeake Bay-wide (166-day) growing season. (BDL = broadleaf large; BDM = broadleaf medium; BDS = broadleaf small; CEL = coniferous large; CEM = coniferous medium; BES = broadleaf evergreen)

i-Tree Forecast Output: Canopy Area for Single Tree Planted

a) Default Broadleaf (ft^2), 5% mortality			
Age	150 FFD	166 FFD	210 FFD
	Valley Ridge and Appalachian Physiographic Region	Chesapeake Bay-wide	Coastal and Piedmont Physiographic Region
5	74 (590)*	79 (550)	92 (470)
10	104 (420)	114 (380)	144 (300)
25	160 (270)	180 (240)	239 (180)
b) Default Broadleaf(ft^2), 2.5% mortality			
5	85 (510)	90 (400)	105 (420)
10	132 (330)	144 (300)	182 (240)
25	271 (160)	304 (140)	399 (110)

* Number of trees per acre

Recommendations for UTC BMP Credit

Decision Rule for Tree Canopy as a BMP and as a Land Use

- Trees will require a minimum of 10 years growth after planting to reach an area necessary to be captured by high resolution imagery and mapped as a land use.
- The next two potential cycles for high resolution imagery mapping are 2017/18 and 2022/23.
- Based on this decision rule, trees planted for BMP credit in 2016 and onward will continue to be tracked as a BMP through 2025.

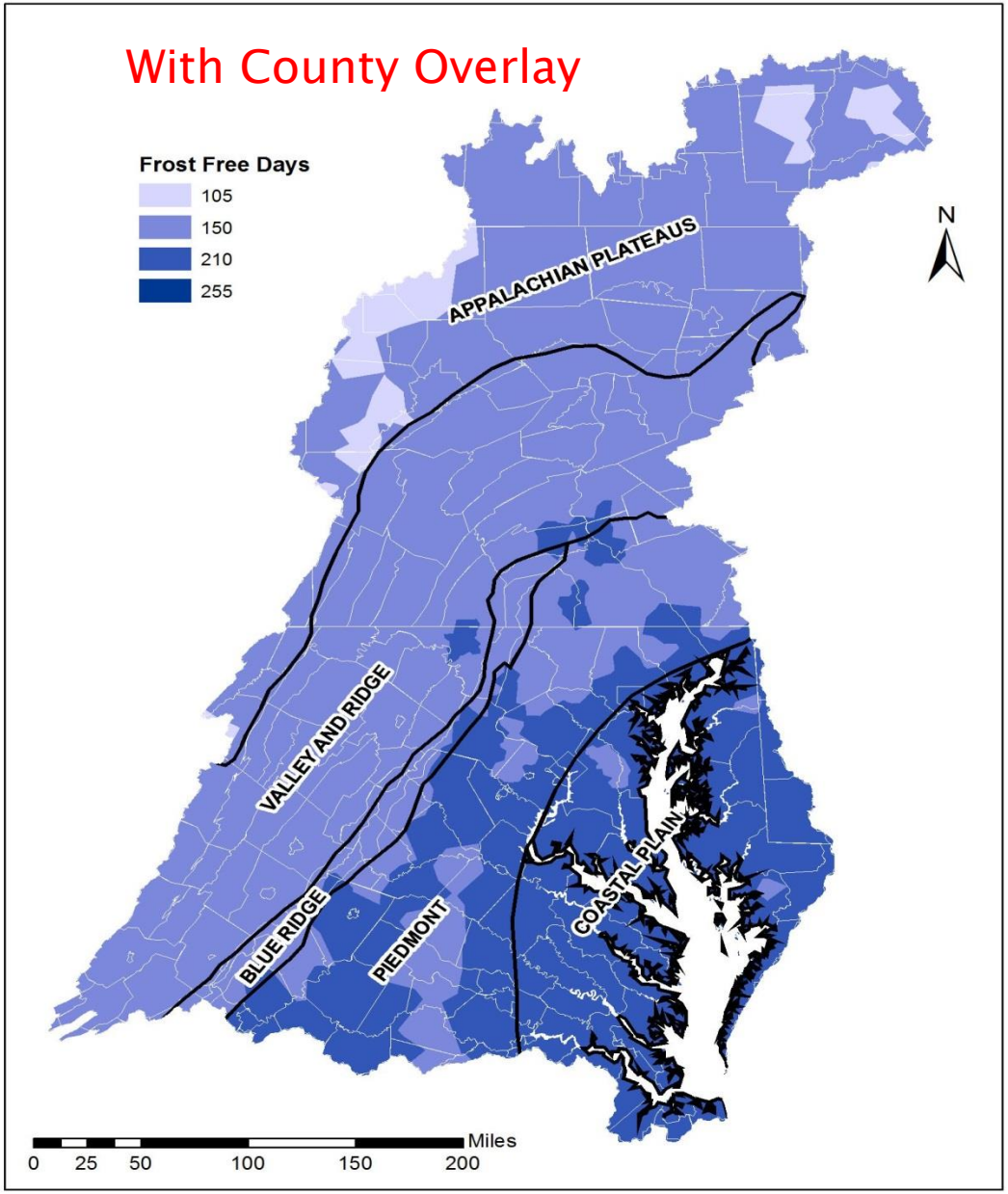
Lifespan of Annual BMP Credit

- Unlike other structural BMPs that have a credit duration due to their expected practice lifespan, urban trees on average have an expected lifespan between 15-28 years, and longer on residential sites (Roman and Scatena 2011, Nowak et al 2004) .
- The lifespan of the BMP credit is based on the time period until it is mapped as a land use based on high resolution imagery (i.e., minimum of 10 years of growth after planting).
- This BMP would not be eligible for renewal in the National Environmental Information Exchange Network (NEIEN) once it is classified as a land use to avoid double counting of tree canopy acreage.

Information for Reporting and Tracking BMP

- Default broadleaf tree as a representative tree to report and track
- This recommendation does not limit the type of trees that are eligible for credit. The credit applies to all tree types (i.e., trees other than broadleaf species may be planted).
- The Expert Panel recommends the Baywide climate of 166 FFD days be used as guidance to provide an average metric for project tree canopy growth. i-Tree Forecast output finds climate has marginal effect on tree growth up to 10 years; avoids complexities of multiple FFDs within a single county

With County Overlay



Metric for Translating Trees Planted to Urban Tree Canopy Acreage

- Annual BMP acreage credit based on 10 years of projected growth after planting.
- The credit for the default broadleaf tree for the Bay-wide climate is 144 square feet for every tree planted (300 trees per acre).
  - The minimum 10 years of projected growth was chosen to assure that trees planted can be identified through high resolution imagery
  - Represents a mid-point in the projected lifespan of the tree that best aligns with the 2025 planning timeframe to have "projects in the ground"
  - Trees planted in 2016 and after will receive the full BMP credit these trees are "over-credited." On the other hand, the trees that survive and continue growing beyond 10 years will be "under-credited."
  - Provides assurance that the continued growth of trees post 2025 will work to maintain the nutrient and sediment caps after the TMDL is met.

Qualifying Conditions

- Report the number of trees planted.
- Jurisdictions may also report the dominant land cover on which the tree is planted (pervious or impervious). If this information is not provided, the CBP will make assumptions based on the current distribution of land uses in the Phase 6 model.

Section 6. Accountability

- Expert Panel does not envision any *unintended consequences*
- Current assumption of no net change in load attributed to leaf litter a "placeholder" for future research.
- Decision rule to avoid *double-counting* of existing tree canopy (mapped land uses) and new tree canopy from BMP

Verification

- Verification is an important process to ensure BMPs implemented continue to function to receive credit
- Review 2014 guidance given update to CBWM with new tree canopy land uses and BMP credit method
- Panel advises Partnership to consider the following:
  - Existing guidance does not align with current credit method that accounts for mortality. Tree replacement not necessary
  - Updates to tree canopy land use using high resolution imagery is the most objective verification process

Section 7: Future Research & Management Needs

Research

1) Evaluate the effect of tree canopy, non-forested lands on water quality.
2) There is a need for collection of multi-year field data that explicitly measures nutrient fluxes associated with areas of tree canopy. The data should be collected in areas representative of applicable conditions within the Chesapeake Bay Watershed. The data can be used to inform future expert panels, new versions of the modeling tools or land use loading rates
3) If new data specific to nutrient fluxes from tree canopy over turf and impervious surfaces in the Chesapeake Bay watershed is not gathered, the CBP partnership can consider whether to adjust, drop, or keep this land-use/BMP as presently recommended for future model versions.

Research (cont'd)

4) Support research to characterize and quantify the impact of leaf litter on nutrient contributions to the urban mass balance
5) Continued research on the effect of soils on tree canopy growth in urban watersheds.

Management

1) Jurisdictions review and adopt guidance for tree planting and post planting care
2) Jurisdictions use tools to evaluate the net loss/gain of tree canopy beyond the Chesapeake Bay land use update.
3) The UTC BMP credit be reevaluated after 2025 to account for the increase in credit post 2025 as trees mature
4) Develop BMP's that address the conservation and maintenance of existing tree canopy.

QUESTIONS & COMMENTS