Chesapeake Bay Program | Indicator Analysis and Methods Document
Tree Canopy | DRAFT VERSION 5/31/2022

Indicator Title: Tree Canopy

Relevant Outcome(s): Tree Canopy

Relevant Goal(s): Vital Habitats

Location within Framework (i.e., Influencing Factor, Output or Performance): Performance

A. Data Set and Source

(1) Describe the data set. What parameters are measured? What parameters are obtained by calculation? For what purpose(s) are the data used?

The Tree Canopy Indicator is designed to measure progress toward the Tree Canopy Outcome in the Chesapeake Watershed Agreement (2014):

"Continually increase urban tree canopy to provide air quality, water quality and habitat benefits throughout the Chesapeake Bay watershed. Expand urban tree canopy by 2,400 acres by 2025"

In the Management Strategy for this outcome, "urban tree canopy" is broadly defined to include existing and newly planted trees in communities of any size – urban, suburban and rural – that are not on agricultural lands.

The Tree Canopy Indicator has two components: 1) urban tree planting BMPs reported by states annually to track progress towards meeting the Chesapeake Bay TMDL; and 2) remotely-sensed changes in tree canopy updated every 4 to 5 years. Both of these components combined represent the annual extent of tree canopy in the Bay watershed, used as our best available estimate for tracking progress for the Tree Canopy Outcome.

1) Reported Tree Planting BMPs

To track real-time progress that jurisdictions and partners are making in planting trees to increase canopy, we will use annual BMP progress data that are reported via the National Environmental Information Exchange Network (NEIEN) to the Chesapeake Assessment and Scenario Tool (CAST). The combined reported acres of Urban Tree Canopy Expansion, Urban Forest Planting, and Urban Forest Buffer BMPs will be used to summarize progress in each state, wherever they are reported in the watershed. The only geographic constraint for reporting these BMPs is that they must be reported on

developed land uses (e.g. turf, impervious surfaces), not on agricultural land uses. BMP progress data will be counted starting from 2014 when the Tree Canopy Outcome was officially adopted through the signing of the Watershed Agreement.

The annual BMP data provide our best real-time estimate of tree canopy expansion efforts. However, this measure only captures anticipated gains, not the losses in tree canopy that we know are occurring across the landscape every day due to development, storms, rising sea levels, invasive pests such as Emerald Ash Borer, and other factors. To track overall net changes in tree canopy, remotely-sensed land cover/land use data are needed to supplement the annual BMP data.

2) Remotely-sensed Changes in Tree Canopy in Developed Areas

Thanks to the Chesapeake Bay Program's investment in high-resolution land cover/land use data with tree canopy classes, we now have a remotely-sensed estimate of tree canopy throughout the watershed for the time periods 2013/14 and 2017/18. Released in May 2022, a land use change analysis was completed using these two time periods of land use data. The results are summarized in Land Use Change Matrices (available at county, state and Bay-side scale) that form the basis of our reporting for this indicator.

The Land Use Change Matrices summarize all transitions to/from the 18 main land use classes covering developed, agricultural and "natural" lands. The Tree Canopy Indicator is computed based on transitions between the non-treed developed land classes (Impervious, Turf, Pervious Developed) and the tree cover classes (Forest, Tree Canopy over Impervious, Tree Canopy over Turf, Other Tree Canopy)

GAINS in tree canopy

From:	**To:**
Impervious Classes	→ Tree Cover Classes *(Forest, TC over Imp, TC over Turf, Other TC)*
Turf	→ Tree Cover Classes *(Forest, TC over Imp, TC over Turf, Other TC)*
Pervious Developed	→ Tree Cover Classes *(Forest, TC over Imp, TC over Turf, Other TC)*

LOSSES in tree canopy

From:	**To:**
Tree Cover Classes	→ Impervious Classes, Turf, or Pervious Developed
(Forest, TC over Imp,	*→ Turf*
TC over Turf,	*→ Pervious Developed*
Other TC)	

Transitions within the tree cover classes *(Forest, TC over Imp, TC over Turf, Other TC)* are not included in the indicator, because tree cover remains consistent in these transitions.

The Tree Canopy Indicator reports on the net change (gains minus losses) over the time periods assessed. The next update of high-resolution land cover and land use data based

on 2021/2022 imagery is scheduled for release in 2024, at which time a new change analysis will be completed and reported for the Indicator.

(2) List the source(s) of the data set, the custodian of the source data, and the relevant contact at the Chesapeake Bay Program.

- Source: 1) NEIEN/CAST BMP progress data and 2) Chesapeake Bay Land Use Change Dataset as summarized in Land Use Change Matrices (CBP/Chesapeake Conservancy)
- Custodian: 1) Sucharith Ravi, CBP/UMCES; 2) Peter Claggett, CBP/USGS,
- Chesapeake Bay Program Contact – Julie Mawhorter, julie.mawhorter@usda.gov, 443-214-6490

(3) Please provide a link to the location of the data set. Are metadata, data-dictionaries and embedded definitions included?

Datasets will be posted once Indicator is approved

B. Temporal Considerations

(4) Data collection date(s): 1) BMP data – 2014-present. 2) CBP Land Use Change data – 2013/14 to 2017/18

(5) Planned update frequency (e.g., annual, biannual, etc.):
- Source Data: 1) BMP data - annual 2) land use – every 4-5 years.
- Indicator: annual

(6) Date (month and year) next data set is expected to be available for reporting: October 2023

C. Spatial Considerations

(7) What is the ideal level of spatial aggregation (e.g., watershed-wide, river basin, state, county, hydrologic unit code)? Watershed-wide and state

(8) Is there geographic (GIS) data associated with this data set? If so, indicate its format (e.g., point, line polygon). CBP Land Use Change Data are available in raster format but indicator data is derived from Land Use Change Matrices.

(9) Are there geographic areas that are missing data? If so, list the areas. No

(10) Please submit any appropriate examples of how this information has been mapped or otherwise portrayed geographically in the past. N/A

D. Communicating the Data

(11) What is the goal, target, threshold or expected outcome for this indicator? How was it established?

The Tree Canopy Outcome was established in the CB Watershed Agreement (2014).

Tree Canopy Outcome: *Continually increase urban tree canopy capacity to provide air quality, water quality and habitat benefits throughout the watershed.* ***Expand urban tree canopy by 2,400 acres by 2025.***

The 2,400 acre goal was set during the drafting of the Watershed Agreement based on estimates provided by each jurisdiction on how much annual progress was an ambitious yet hopefully reasonable target:

Jurisdiction	Annual Target (New Acres)	2025 Target (New Acres)
Delaware	5	60
DC	40	480
Maryland	45	540
New York	5	60
Pennsylvania	60	720
Virginia	40	480
West Virginia	10	120
TOTAL	**205**	**2460**

(12) What is the current status in relation to the goal, target, threshold or expected outcome? TBD Summer 2022

(13) Has a new goal, target, threshold or expected outcome been established since the last reporting period? Why? – No, this is a new indicator with first reporting in 2022

(14) Has the methodology of data collection or analysis changed since the last reporting period? How? Why? No

(15) What is the long-term data trend (since the start of data collection)? TBD Summer 2022

(16) What change(s) does the most recent data show compared to the last reporting period? To what do you attribute the change? Is this actual cause or educated speculation? TBD Summer 2022

(17) What is the key story told by this indicator? TBD Summer 2022

E. Adaptive Management

(18) What factors influence progress toward the goal, target, threshold or expected outcome?

From Tree Canopy Outcome Logic Table/Workplan:

- Funding and Finances
- Federal and State Government Agency Engagement
- Local Government Agency Engagement
- Legislative Engagement at State and Local Level: Policies and Ordinances
- Partner Coordination
- Scientific and Technical Understanding: Technical Capacity and Knowledge
- Public and Landowner Engagement: Education and Outreach
- Environmental Factors Challenging Tree Canopy progress:
    - Population Growth (Development);
    - Climate Change (storms, pests, invasive species, drought, etc.)
    - Biota (pests, invasive species, etc.)
    - Habitat Condition (poor soils, utility/infrastructure conflicts, etc. impacting urban tree plantings)

(19) What are the current gaps in existing management efforts?

Gaps generally are related to limitations in 1) adequate funding/partnerships, 2) effective policy and ordinances, 3) technical capacity and knowledge, including tracking/reporting tools to capture progress, and 4) education and outreach capacity See Tree Canopy Management Strategy and Logic Table/Workplan for more details

(20) What are the current overlaps in existing management efforts?

State urban forestry programs, CB-wide coordination through Forestry Workgroup, local government management of the urban forest (county and/or city/town), TMDL/WIP planning efforts for urban BMPs

(21) According to the management strategy written for the outcome associated with this indicator, how will we (a) assess our performance in making progress toward the goal, target, threshold or expected outcome, and (b) ensure the adaptive management of our work?

The biennial Strategy Review System (SRS) process by the CBP Management Board for each outcome is the primary process we will use to assess our performance in making progress toward the Tree Canopy outcome. The next review will be held in early 2023 and the Tree Canopy 2-year workplan will be adapted shortly after based on what we learn from the review, including Management Board and stakeholder input.

F. Analysis and Interpretation

Please provide appropriate references and location(s) of documentation if hard to find.

(22) What method is used to transform raw data into the information presented in this indicator? Please cite methods and/or modeling programs.

1) CAST scenarios are used to pull BMP progress data reported annually from 2014 to present for 3 urban tree BMPs: urban tree planting (canopy), urban forest planting, and urban forest buffers. The data are taken from custom "no expiration" scenarios in CAST. As tree planting numbers reported in CAST are cumulative, scenarios are created for the focal year and the preceding year to calculate the number of new tree planting acres added for the focal year. These numbers are extracted from the "submitted vs. credited" report in CAST, and numbers are summed from the three urban tree BMPs.
2) Land Use Change Matrices are developed from the land use change raster datasets by the CBP Land Use team following methods described in the following documentation (link Appendix)

(23)Is the method used to transform raw data into the information presented in this indicator accepted as scientifically sound? If not, what are its limitations? yes

(24) How well does the indicator represent the environmental condition being assessed?

The biggest limitation in the Indicator is that the annual BMP progress data are 1) incomplete, not capturing all the plantings going on, and more importantly 2) only reflect reported gains, and do not capture losses we know are occurring on the landscape every day through development, storms, pests/diseases, removals and natural mortality. This limitation is addressed through the land use change data, but there will always be challenging time lags between tree plantings reported and when they show up in the land use data (approximately 10-15 years after planting).

(25) Are there established reference points, thresholds, ranges or values for this indicator that unambiguously reflect the desired state of the environment? No

(26) How far can the data be extrapolated? Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where

measurements were made (e.g., statistical survey inference, no generalization is possible)?

We have not yet developed methods to extrapolate the land use change data beyond the two time periods available.

G. Quality - will be completing this section soon, with help from CBP staff
Please provide appropriate references and location(s) of documentation if hard to find.

(27) Were the data collected and processed according to a U.S. Environmental Protection Agency-approved Quality Assurance Project Plan? If so, please provide a link to the QAPP and indicate when the plan was last reviewed and approved. **If not, please complete questions 29-31.**

(28) *If applicable:* Are the sampling, analytical and data processing procedures accepted as scientifically and technically valid?

(29) *If applicable:* What documentation describes the sampling and analytical procedures used?

(30) *If applicable:* To what extent are procedures for quality assurance and quality control of the data documented and accessible?

(31) Are descriptions of the study design clear, complete and sufficient to enable the study to be reproduced?

(32) Were the sampling, analytical and data processing procedures performed consistently throughout the data record?

(33) If data sets from two or more sources have been merged, are the sampling designs, methods and results comparable? If not, what are the limitations?

(34) Are levels of uncertainty available for the indicator and/or the underlying data set? If so, do the uncertainty and variability impact the conclusions drawn from the data or the utility of the indicator?

(35) For chemical data reporting: How are data below the MDL reported (i.e., reported as 0, censored, or as < MDL)? If parameter substitutions are made (e.g., using orthophosphate instead of total phosphorus), how are data normalized? How does this impact the indicator?

(36) Are there noteworthy limitations or gaps in the data record?

H. Additional Information (*Optional)*

(37) Please provide any further information you believe is necessary to aid in communication and prevent any potential misrepresentation of this indicator.