Ecosystem Services Projects Update

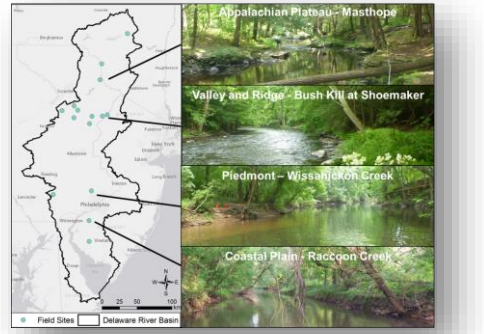
STAR—Feb 24, 2022

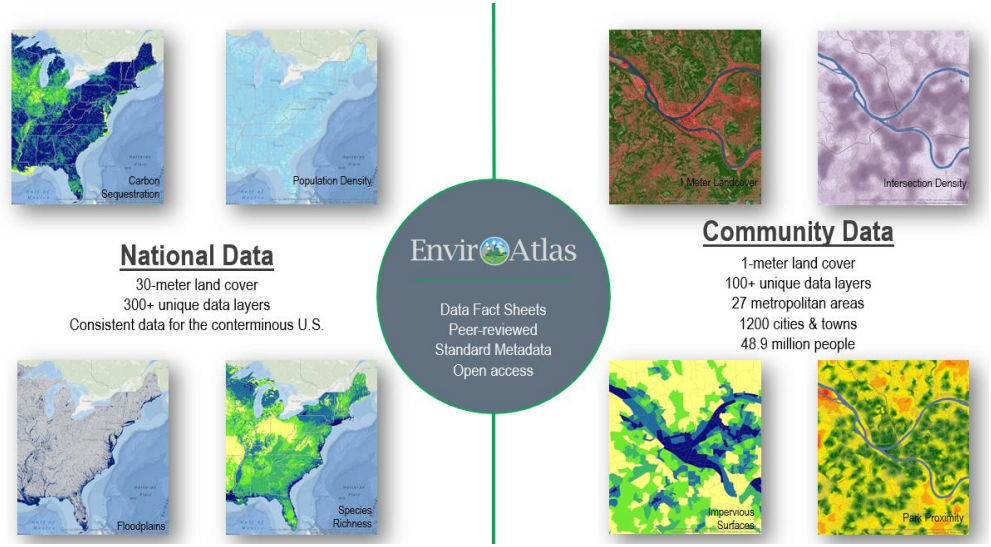
Chesapeake Bay Program

Science. Restoration. Partnership.

ES Projects at CBP

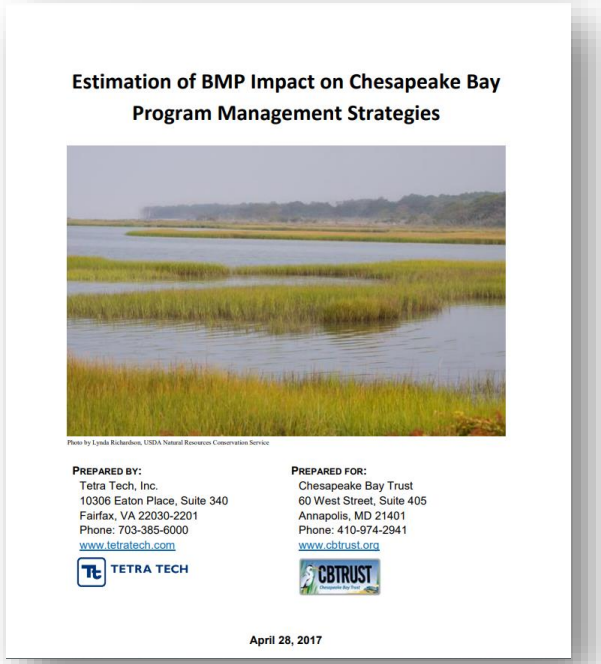
- Projects of USGS Science and Decisions Center
  - Chesapeake Bay Watershed Local Stream Ecosystem Services (Project Website)
  - Co-benefits of BMPs for recreational fishing
- Developing High-Resolution Metrics of ES for Mid-Atlantic (EPA, Enviroatlas)

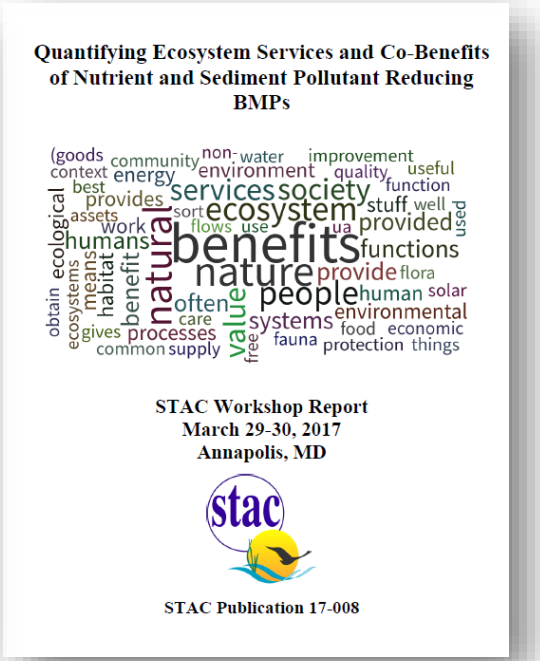




ES Projects at CBP

- Beyond Environmental Benefits Database and Search Tool
- Quantification of the Value of Green Infrastructure Hazard Mitigation Related to Inland and Coastal Flooding (GIT-Funded
- BMP Impact Scoring (Tetra Tech, CAST)
- NOAA Chesapeake Bay Office Research





Ecosystem services assessment for management in the Chesapeake Bay Watershed

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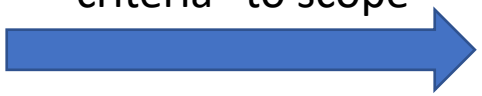
Goal: Describe how ecosystem services may change as Best Management Practices to restore ecosystem condition are implemented

Specifically interested in BMPs that are:

1. Lagging in implementation
2. Relevant to upstream communities
3. Have associated Watershed Agreement goals that have not been met
4. Related to habitat conservation or restoration

Used these 4 "criteria" to scope



Scoped list of BMPs:

- Agricultural forest buffers
- Agricultural grass buffers
- Agricultural tree planting
- Agricultural cover crops
- Urban forest buffers
- Urban forest planting
- Urban tree planting
- Forest conservation
- Wetland creation & restoration
- Impervious surface reduction

Approach: The Ecosystem Services Gradient (ESG)

ESG Goal: Describe how ecosystem services may change along changing ecological conditions

Ecosystem Services Gradient Framework	Generic Process
What ecosystem services (ES) are relevant?	Identify and prioritize ES with stakeholders
How will we measure them?	Identify ES metrics and indicators, and the biophysical attributes that provide them
What ES could we have?	Establish potential availability under a range of bio-physical conditions
What ES do we have now?	Measuring, mapping, and ecological production functions (EPFs)
What ES do we want?	Evaluate co-benefits and tradeoffs
How do we get there?	Identify impacts of management actions
What are the social and economic consequences?	*Conduct and communicate benefits assessment using ecological benefit functions (EBFs)*

This project covers these steps.

Potential future step.

What Ecosystem Services have we focused on?

Scoped list of Ecosystem Services:

- Air quality
- Habitat quality (for birds & brook trout)
- Temperature Reduction
- High quality soil
- Risk of flooding
- Water clarity
- Water quality- nutrients in groundwater
- Water quality- pathogens in water sources
- Water quantity
- Open space /Green Space
- Pollinator fauna
- Pest predator/depredator fauna
- Edible flora

Note:

- We arrived at this list by using classification systems, combing through CBP documents (e.g., co-benefits report), and solicited feedback from CBP partners.
- This project is intended to be a starting place for this work which is why we needed to scope and prioritize ecosystem services.

How will we share these results?

- EPA style report:
  - Composed of individual fact sheets that CBP and CBP partners can adapt for their needs

- Integrate with CAST:
  - Developed methods that can be used to determine a per acre estimate of an ecosystem service with the goal of users receiving info such as:
    If you implement X acres of a BMP, you may get…
      - X number of bird species
      - X lb/acre of pollutants removed
      - X lb/acre/yr of C stored or sequestered
  - Work with CAST on a visual tool that displays connections between BMPs, ES, and Watershed Outcomes
- Integrate with Watershed data dashboard
  - Share data to map current estimates of each ecosystem service
  - Incorporate fact sheets here as well

EPA report fact sheet example:

BMP: Forest Buffers

What is a forest buffer?

Forest buffers create forest like habitat that may provide many ecosystem services. They are linear wooded areas that help filter nutrients, sediments and other pollutants from runoff as well as remove nutrients from groundwater. The recommended buffer width is 100 feet, with a 35 feet minimum width required (CBP BMP Guide citation). Forest buffers can be placed on agricultural land or urban lands (Chesapeake Bay Program, 2018). Forest Buffers are currently implemented at varying acreages across the watershed with the largest implementation in Worcester County, MD (Fig 2).

What are the additional benefits of implementing a forest buffer BMP?

Forest buffer BMPs help reduce N, P and sediment loads while also providing additional ecosystem services. For example, forest buffers may provide habitat for birds, pollinators and small mammals which may benefit hunters and wildlife viewers and farmers (Fig 3, 4). In total, we identified 35 potential ecosystem services provided by Forest Buffer BMPs that would benefit 37 potential user groups.

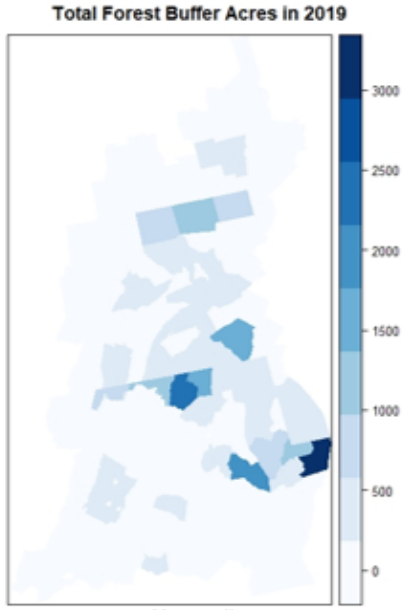


Figure 2 Total acres of forest buffer BMPs implemented at the county level.

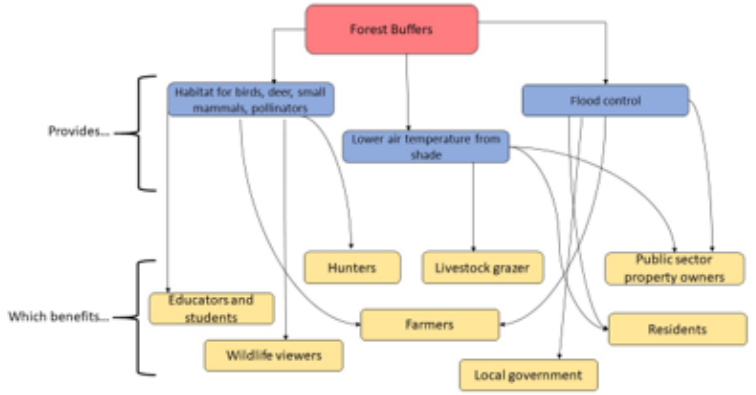


Figure 3 BMPs (red box) provide ecosystem services (blue box) which benefit different user groups (yellow box). Forest Buffer BMPs provide habitat for various species which benefits wildlife viewers who are interested

What Watershed Outcomes may benefit from forest buffers?

We identified a direct connection between Forest Buffers and 16 of the 31 outcomes. The outcomes we identified are listed below:

2025 WIP
Adaptation
Black Duck
Blue Crab Abundance
Brook Trout
Fish Habitat
Forest Buffer
Healthy Watersheds
Oyster
Protected Lands
Public Access Site Development
Stream Health
Submerged Aquatic Vegetation (SAV)
Toxic Contaminants Policy and Prevention
Tree Canopy Outcome
Wetlands

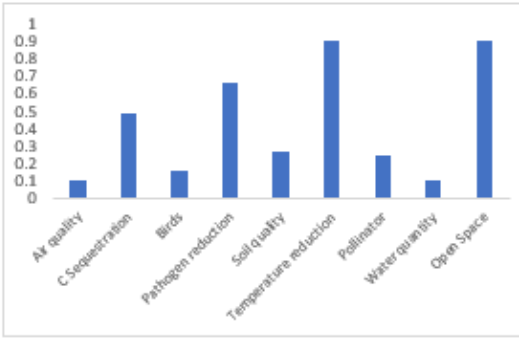


Figure 4 Relative provisioning of FES for Forest Buffers.

EPA report fact sheet example:

Final Ecosystem Service: Air quality

Why is air quality important?

Air quality can impact your health and ecosystem health.

Who is impacted by air quality?

There are many beneficiaries, or users of an ecosystem, that benefit from the final ecosystem service of air quality. All humans, public sector property owners, residents who own property, residents who rent, residents in low income or disadvantaged areas, and resource dependent businesses are examples of beneficiaries.

How do we quantify air quality?

The first step is to identify a metric that may be modeled, measured, or monitored that corresponds to air quality. There are many variables that can impact air quality including concentration of pollutants in the air, pollen, air temperature, and weather patterns. We have chosen to focus on pollutants such as CO, SO2, NO2, O3, PM2.5, PM10 and quantify how tree cover contributes to air pollutant removal using methods developed by iTree (https://www.itreetools.org/). Briefly, we used multipliers of air pollutant removal rates developed by iTree and multiplied by tree cover to determine air pollutant removal potential for each of the six pollutants (Fig 1). Tree cover was determined for each county using the Chesapeake Bay Conservancy 2013/2014 1m land use landcover dataset.

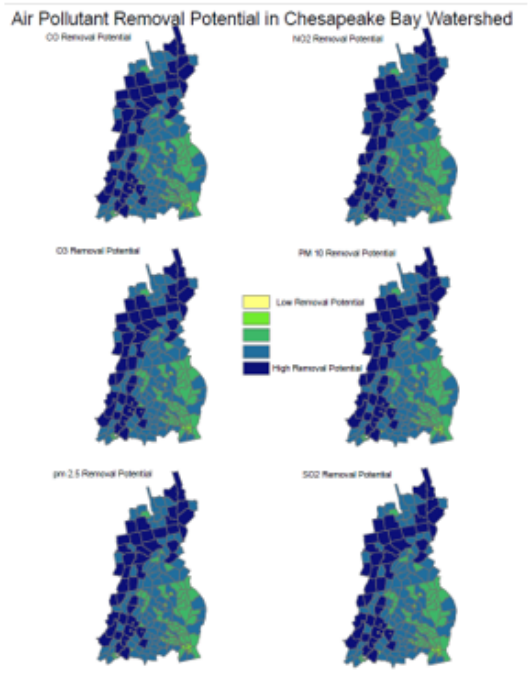


Figure 34 Current Air Pollutant Removal Potential by county within Chesapeake Bay Watershed. Counties with lower removal potential may want to take actions to increase tree cover.

Limitations

This method is based on iTree methods that were developed for the entire United States, as a result, we are using averages from the entire US to provide pollutant removal estimates.

How can this information be used?

You can use the current pollutant removal rate estimates to determine where in the watershed to consider planting more trees to aid with pollutant removal.

What Watershed Agreement Outcomes may benefit from improving air quality?

By improving air quality, you may also impact the following Watershed Agreement Outcomes: Stream health, 2025 WIPS, Healthy watersheds, public access development, Adaptation

What Watershed Agreement Outcomes may help improve air quality?

Wetlands, Forest buffers, Tree canopy

What best management practices (BMPs) may help improve air quality?

BMPs that increase tree cover are especially important in improving air quality because trees can capture pollutants in the air. For BMPs implemented on agricultural lands, a rural multiplier is used. For BMPs implemented on urban lands, an urban multiplier is used. Once we determined which multiplier to use, we simply multiplied the number of acres of a BMP times the correct multiplier. The table below shows estimates for different pollutant removals based on 20 acres of a BMP implemented. Units are lb/acre/yr.

BMP NAME	CO REMOVED	O_3 REMOVED	SO_2 REMOVED	NO_2 REMOVED	$PM_{2.5}$ REMOVED	PM_{10} REMOVED
FOREST BUFFERS	17.9	97.3	981.0	330.6	47.5	62.0
URBAN FOREST BUFFERS	22.7	125.0	965.2	274.0	49.3	61.4
URBAN TREE PLANTING	22.7	125.0	965.2	274.0	49.3	61.4
TREE PLANTING	17.9	97.3	981.0	330.6	47.5	62.0

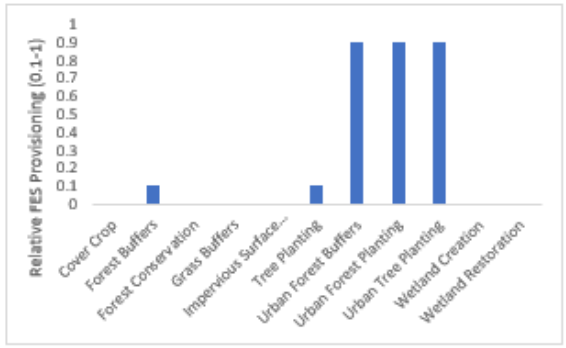


Figure 35 Relative provisioning of Air Quality (air pollutant removal) for each BMP. BMPs with no values indicate insufficient data to estimate air pollutant removal.

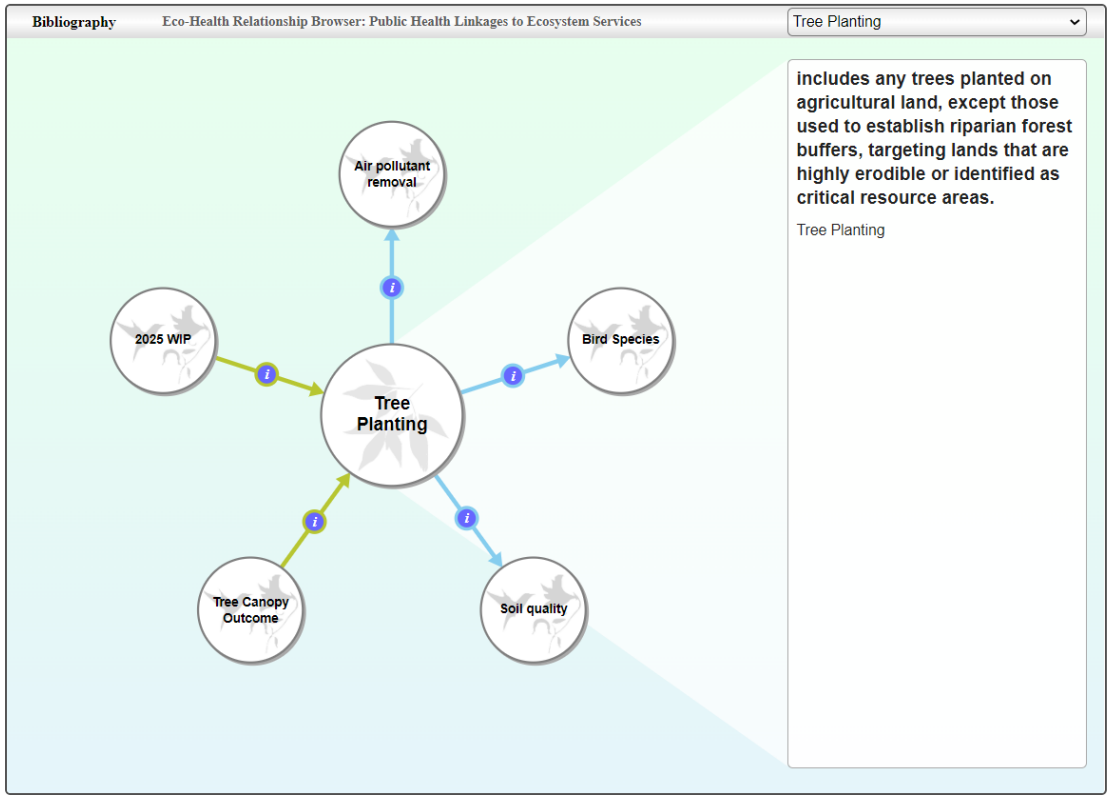
Additional resources:
https://www.itreetools.org/
https://www.chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/

CAST examples:

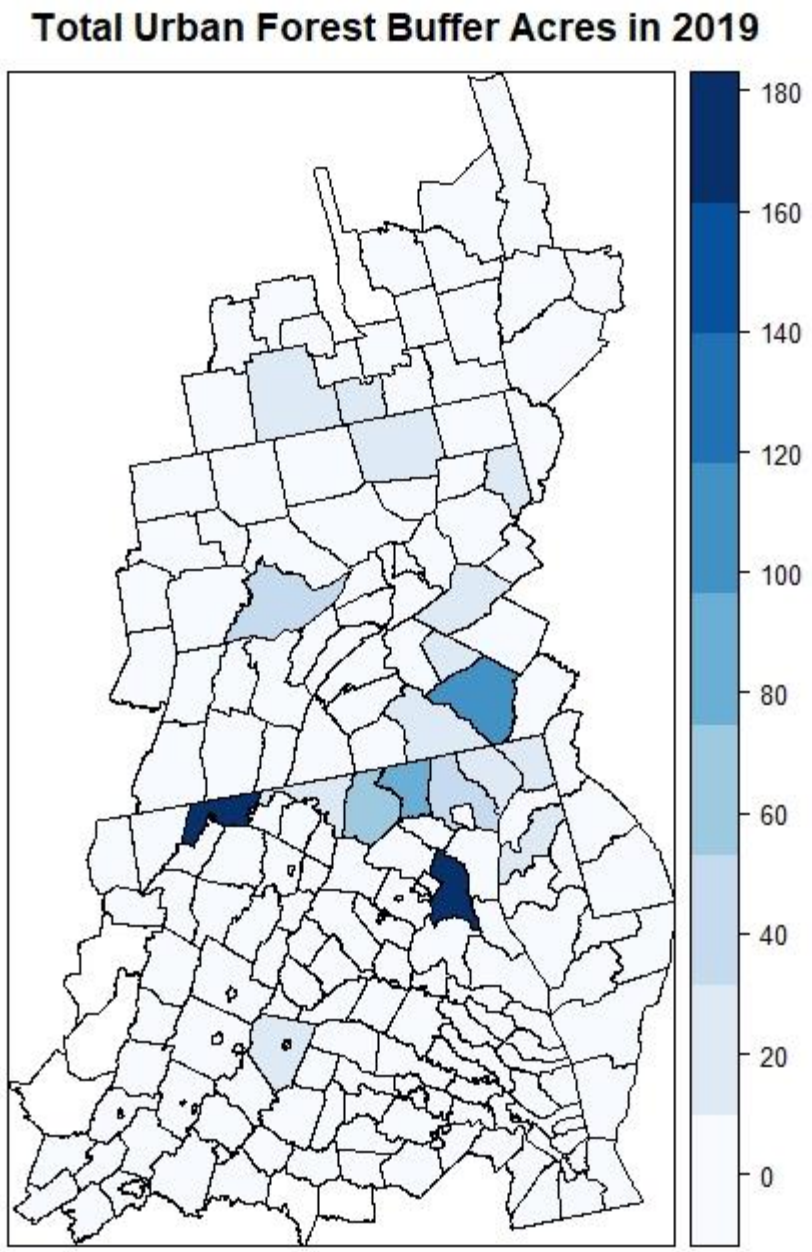
Example ES report for 20 acres of Forest Buffers:

ES	Supply of ES	Units
CO removed	17.9	Lb yr-1
PM 2.5 removed	47.5	Lb yr-1
Bird species richness	77	richness
Pathogen reduction	4.34E-04	% FIB removal

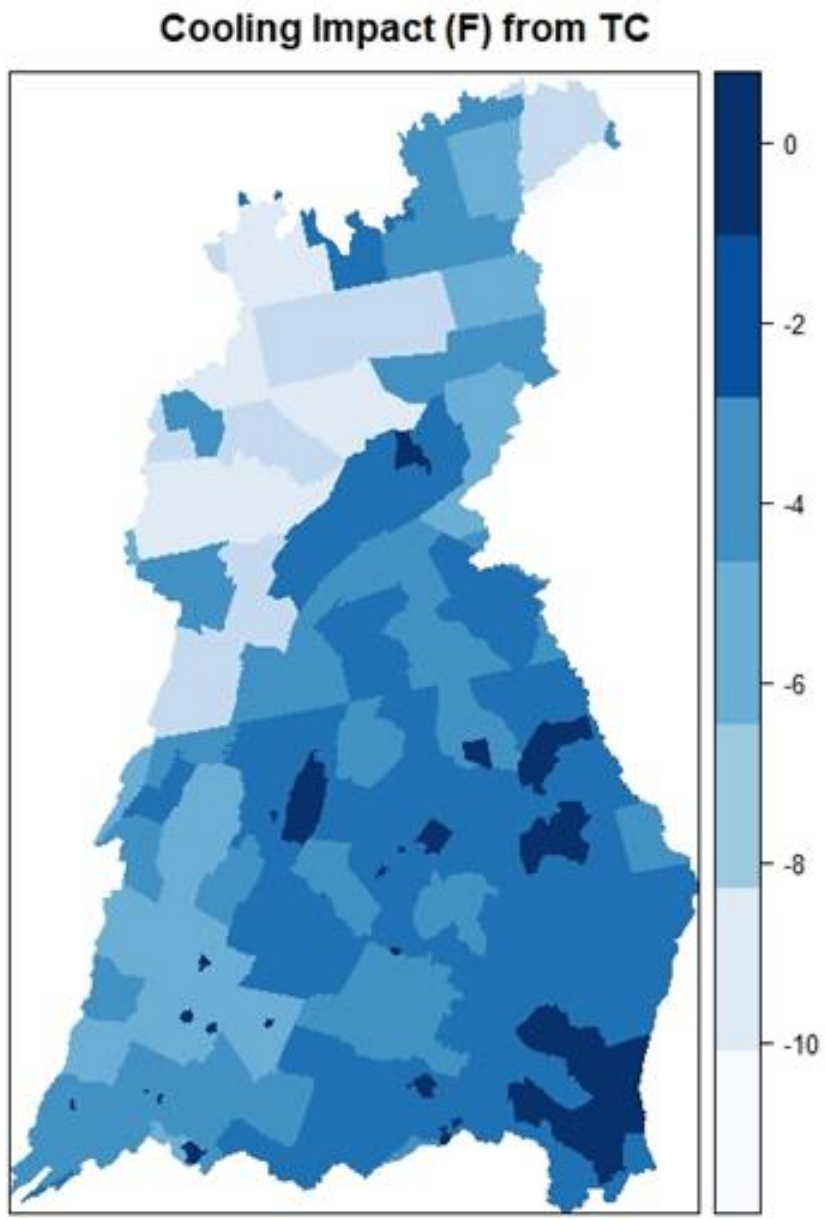
Example of visual tool to view connections:



Data Dashboard example:



Provide current maps of BMP implementation and Ecosystem Service supply



We need to identify metrics to quantify ecosystem services

Note: These metrics need to resonate with beneficiaries AND have suitable data or models. Our project is focused on quantifying ecosystem services, not valuation

Ecosystem Service	Short list of metrics	Source
Air quality	concentration of CO, NO2, O3, PM 10, PM 2.5, SO2	iTree (Nowak 2020)
Edible flora	plant diversity, cover of edible species	EnviroAtlas (Pickard et al. 2015)
Habitat quality	habitat suitability for species of interest, species richness	inVEST; Smith et al 2017 (Smith et al. 2017, Sharp et al. 2020)
Heat risk	daytime and nighttime temperature reduction	EnviroAtlas (Pickard et al. 2015)
High quality soil	soil C content, N fixation, pH, salinity, type, percent sand, bulk density, organic matter	NESP; Smith et al, 2017 (Russell et al. 2013, Olander et al. 2017, Smith et al. 2017)
Open space	open space access index; distance to open space	EnviroAtlas; NESP (Russell et al. 2013, Pickard et al. 2015, Olander et al. 2017)
Pest predator/depredator fauna	density of certain pest predators (e.g., ladybugs)	ESML (US EPA 2020)
Pollinator fauna	area of wild pollinator habitat; ratio of pollinator habitat to pollinator dependent crops	EnviroAtlas; inVEST (Pickard et al. 2015, Sharp et al. 2020, Warnell et al. 2020)
Risk of flooding	flood depth, duration, extent and frequency; maximum retained rainwater; soil precipitation retention; surface water runoff; wave attenuation	EnviroAtlas; inVEST; EPA H2O; ESML (Russell et al. 2013, Pickard et al. 2015, Sharp et al. 2020)
Water clarity	mean sediment retention; secchi depth; turbidity	Angradi et al. (2018)
Water quality- nutrients	concentration of nitrates in groundwater	Terziotti et al. (2018)
Water quality- pathogens	concentration of harmful bacteria (e.g., fecal coliform)	Yee et al. (2021)
Water quantity	water availability	inVEST (Sharp et al. 2020)

EPA report fact sheet example:

Watershed Agreement Outcome: Adaptation

Continually pursue, design and construct restoration and protection projects to enhance the resiliency of Bay and aquatic ecosystems from the impacts of coastal erosion, coastal flooding, more intense and more frequent storms, and sea level rise.

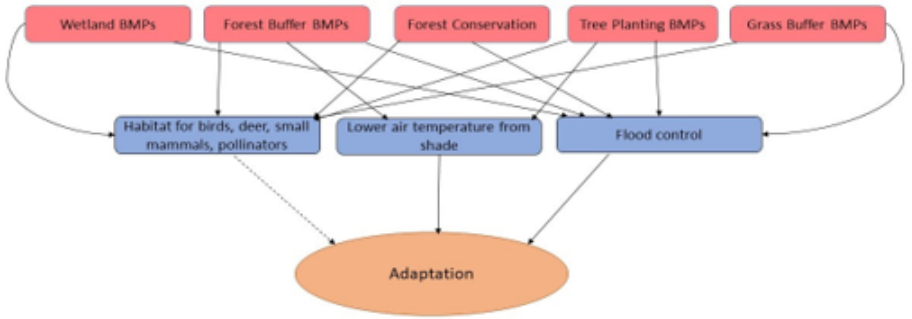


Figure 46 Best Management Practices (red box) may provide ecosystem services (blue box) that may directly (solid line) or indirectly (dashed line) contribute to meeting a watershed outcome (orange circle). Many of the BMPs above provide flood control services which directly contributes to meeting the Adaptation Outcome.

What BMPs contribute to this outcome?

BMPs provide ecosystem services such as habitat and flood control which may directly or indirectly contribute to meeting the Adaptation outcome. Out of the 11 BMPs that we have focused on for this report, 9 of them (in bold) would contribute to Adaptation. In addition, a previous report identified additional BMPs that would also contribute (cite co benefits report).

- **Urban Forest Buffers**
- **Urban Tree Planting**
- Dirt/Gravel Roads
- Urban Shoreline Management
- Urban Stream Restoration
- Abandoned Mine Reclamation
- Advanced Grey Infrastructure

Nutrient Discovery Program

- Bioretention
- Dry Ponds
- Erosion and Sediment
- Filtering Practices
- **Grass Buffers**
- **Impervious Surface Reduction**
- Infiltration Practices
- Permeable Pavement
- Runoff Reduction
- Street Sweeping
- Urban Growth Reduction
- Wet Ponds
- **Wetlands**
- **Forest Conservation**
- Forest Harvesting Practices
- Urban Stream Restoration
- **Ag Forest Buffer**
- **Ag Tree Planting**

Who benefits from this outcome?

By implementing BMPs that provide ecosystem services to help meet the Adaptation outcome, user groups, or beneficiaries benefit. For example, residents and businesses benefit from flood control.

Questions