State of Chesapeake Forests 2.0 - Plantable Areas, Fragmentation

4 September 2024
Forestry Workgroup Meeting

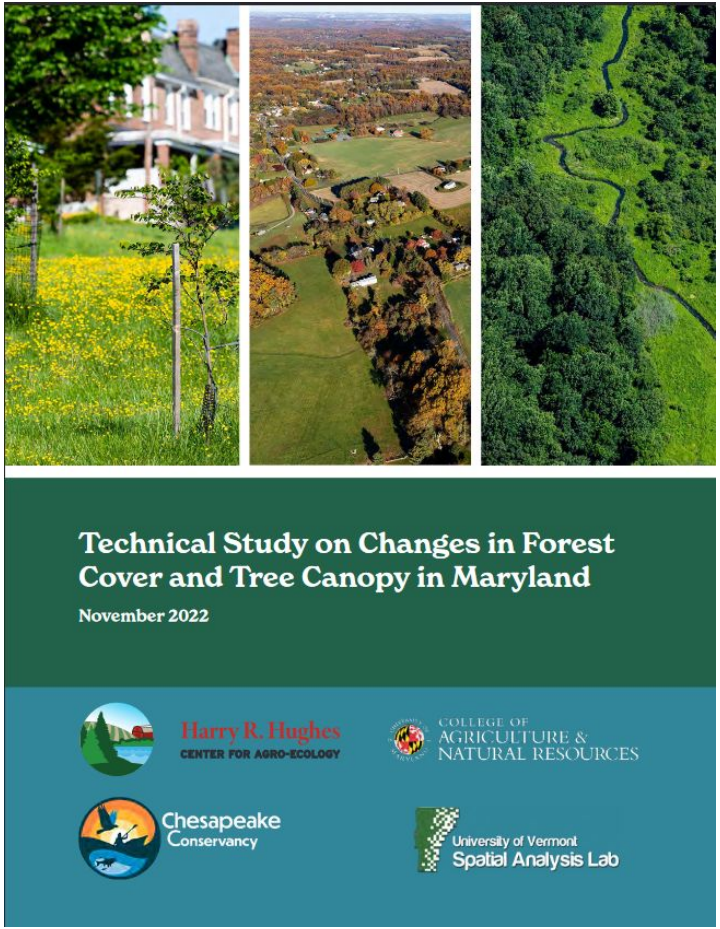
Conservation Innovation Center
Spatial Data Science Lab of the Chesapeake Conservancy

Grant Number: G23AC00545-00

Methodology Design

Maryland Forest Technical Study - Report and StoryMap

- Pages 86-89 - Data and Methods (details to come)
- Products will be similar to those on the right
- Basis will be 2024 edition Chesapeake Bay Program 1-meter Land Use/Land Cover Data (reflective of 2021/22 conditions)



Plantable Area Analysis - Goals and Priorities

- The MFTS analysis sought to identify **easily planted areas**, not all plantable areas, which excluded some opportunities
- Definitions and methods used in the MFTS were identified through Maryland's Forest Conservation Act and supplemented with additional information gathered through county forest conservation regulations.

- **What should be the guiding principle for the SOCF analysis?**
  - **Focus on larger, more easily plantable areas, or broader inclusion of all plantable spaces?**

Table 21. Geographic limitations for afforestation, reforestation or retention that add to or alter the priorities delineated in the FCA.

County	Geographic limitations for afforestation, reforestation or retention that add to to alter those delineated in the FCA / *Limitations on the location of forest mitigation banks*
Baltimore	Minimum stream buffer of 75 ft for surface water designated use I streams and 100 ft for III and IV streams; riverine not 100-year floodplains; slope stabilization of 10% or greater slopes with a soil erodibility K value > 0.24 rather than 15% and >0.35 in FCA.
Carroll	No width specified for stream and wetland buffers or forest corridors; floodplains not included.
Cecil	Minimum stream buffer width of 110 ft for perennial streams.
Charles	Establish or enhance forest plantings on marginal agricultural areas.
Dorchester	Establish forest areas on lands not considered to be prime agricultural lands, as per the County Soil Conservation District / *Requirements for banks: Existing forestland of 10 acres or more; Establishment of riparian forest buffer planting along agricultural stream systems; Enhancement of riparian forested areas by planting adjacent to existing riparian areas; Establishment of planting on less productive agricultural soils.*
Frederick	Areas identified as green infrastructure network and/or sensitive species areas / *Requirements for banks: New or existing forests that provide buffers for streams, creeks, floodplains, wetlands or other hydrologically-sensitive areas on lands that are zoned Agriculture or are primarily in bona fide agricultural use; Existing forest that is critical habitat for threatened or endangered plant or sedentary animal species; Other areas that are i) Water recharge zones for municipal or county public water supplies ii) Not owned by a municipality or other governmental entity iii) Not otherwise substantially protected by Forest Resources chapter of Code or County Zoning Ordinance requirements and iv) Of such significance that loss of forest or the lack of creation of forests on such areas would cause a deleterious effect on the health, safety and welfare of the citizens.*
Howard	Rare, threatened or endangered species; Trees that are part of an historic site or associated with an historic structure; Specimen trees; Green infrastructure network; 75' or 100' undisturbed buffer for perennial streams in residential zoning districts; In or near wetland areas; Slopes of 25% or greater which are at least 20,000 sq. ft. or adjacent to streams or wetlands; Infill between isolated forest stands and groves of specimen trees; Property line or right-of-way buffers that are at least 50 ft wide / *For properties protected by a County Agricultural Land Preservation Easement, banks may only be established in the following areas: Stream buffers - a maximum of 100 feet on either side of the stream bank; Wetlands and wetland buffers - a maximum of 50 feet from the edge of the wetland; Slopes - 25% or greater; Howard County Green Infrastructure Network.*
Kent	Minimum stream buffer width of 100 ft for perennial and intermittent streams.
Montgomery	**Floodplains, stream buffers, steep slopes and critical habitats; Contiguous forests; Rare, threatened and endangered species; Trees connected to an historic site; Champion and other exceptionally large trees; Areas designated as priority save areas in a master plan or functional plan.
Prince George's	**Green infrastructure network elements; Critical habitat areas; Contiguous wooded areas with: high structural and species diversity, few nonnative and invasive species present, very good overall stand health and high potential to provide a significant amount of habitat for forest interior dwelling plant, animal and bird species; Champion trees designated by the federal, state, county or municipal governments; Specimen and historic trees; Forest Legacy Areas; Trees associated with a historic site or resource; Areas adjacent to Primary Management Areas; 100-year floodplains; Wetlands and their buffers; Regulated streams and their buffers; Extensive areas of steep and severe slopes; Hydric soils associated with wetlands and highly erodible soils on slopes 15 percent and greater; Forest Interior Dwelling Species (FIDS) habitat.
Queen Anne's	Minimum stream buffer width of 100 ft for perennial streams.
Somerset	**Nontidal wetlands and associated buffers; Stream buffers (50 feet from stream bank); Critical habitats of rare, threatened, or endangered species; Slopes greater than 15%; Highly erodible soils; Areas immediately adjacent to existing forests; Areas which may serve as buffers between differing land uses / *Requirements for banks: Existing forestland of 10 acres or more; Establishment of riparian forest buffer planting along agricultural stream systems; Enhancement of riparian forested areas by planting adjacent to existing riparian areas; Establishment of planting on less productive agricultural soils.*
Washington	No width specified for stream buffers / *Requirements for banks: Existing forestland of 10 acres or more; Establishment of riparian forest buffer planting along agricultural stream systems; Enhancement of riparian forested areas by planting adjacent to existing riparian areas; Establishment of planting on less productive agricultural soils.*
Worcester	**Located along a coastal bay or a perennial or intermittent stream; Adjacent to and joined with an existing forested area of at least fifty acres in size; Designated as being within a state or County greenway node or corridor; Located within a one-hundred-year floodplain; Located within the C-1 Conservation District as defined by § ZS 1-108 of the Worcester County Zoning Ordinance and as shown on the official Zoning Maps; Wetlands comprise no more than twenty-five percent of the site.

Plantable Area Analysis - Land Use/Land Cover Review

- Suitable land area: areas of existing low vegetation and barren land cover, including turf grass and herbaceous cover.
  - Low Vegetation and Barren (LC)
  - Turf Grass, Natural Succession (Barren), Natural Succession (Herbaceous) (LULC)
- Unsuitable land area: impervious areas, including roads and buildings, wetlands, and water
- Other exclusions (based on auxiliary data): airports, beaches, ecologically sensitive areas, prime agriculture, important bird areas, powerlines, railroads, areas with anticipated sea level rise, cemeteries, and golf courses
- **Which LULC classes should be used to define suitable areas based on the updated 2024 edition classification?**

Figure 6. Classification of plantable areas in Baltimore City by size.

Chesapeake Bay Land Use/Cover Classification (2024 edition, 56 classes)

Water and Water Margins

- 10 Tidal Waters
- Lentic
  - 11 Lakes & Reservoirs
  - 12 Riverine Ponds
  - 13 Terrene Ponds
- Lotic
  - 14 Streams and Rivers
- Water Margins
  - 15 Bare Shore

Development

- Impervious
  - 20 Roads
  - 21 Structures
  - 22 Other Impervious (Parking lots, driveways)
  - 23 TC over Roads
  - 24 TC over Structures
  - 25 TC over Other Impervious
  - 31 Extractive Impervious
  - 32 Solar Field Panel Arrays (impervious)
- Pervious
  - 26 Tree Canopy over Turf Grass
  - 27 Turf Grass
  - 28 Bare Developed
  - 30 Extractive Barren
  - 33 Solar Field Barren
  - 34 Solar Field Herbaceous
  - 35 Solar Field Shrubland
  - 36 Suspended Succession Barren
  - 37 Suspended Succession Herbaceous
  - 38 Suspended Succession Shrubland

Forest

- Tree Canopy
  - 40 Forest
  - 41 Tree Canopy Other (now Forested Other)
- Open Space (temporary)
  - 42 Natural Succession Barren
  - 43 Natural Succession Herbaceous
  - 44 Natural Succession Shrubland
  - 45 Harvested Forest Barren
  - 46 Harvested Forest Herbaceous

Wetlands

- Riverine
  - 50 Riverine Wetlands Barren
  - 51 Riverine Wetlands Herbaceous
  - 52 Riverine Wetlands Shrubland
  - 53 Riverine Wetlands Tree Canopy
  - 54 Riverine Wetlands Forest
  - 55 Riverine Wetlands Harvested Forest
- Terrene
  - 60 Terrene Wetlands Barren
  - 61 Terrene Wetlands Herbaceous
  - 62 Terrene Wetlands Shrubland
  - 63 Terrene Wetlands Tree Canopy
  - 64 Terrene Wetlands Forest
  - 65 Terrene Wetlands Harvested Forest
- Tidal
  - 70 Tidal Wetlands Barren
  - 71 Tidal Wetlands Herbaceous
  - 72 Tidal Wetlands Shrubland
  - 73 Tidal Wetlands Tree Canopy
  - 74 Tidal Wetlands Forest
  - 75 Tidal Wetlands Harvested Forest

Agriculture

- Productive Lands
  - 80 Cropland Barren
  - 81 Cropland Herbaceous
  - 82 Orchards and Vineyards Barren
  - 83 Orchards and Vineyards Herbaceous
  - 84 Orchards and Vineyards Shrubland
  - 85 Pasture and Hay Barren
  - 86 Pasture and Hay Herbaceous

Analogous previously used classes:

Plantable areas

Potential additional consideration: longevity of tree plantings in hypothetical locations

- In addition to identifying areas for tree planting based on land use and ancillary datasets, it may be helpful to consider where tree plantings may be most likely to survive for the next several decades
- Potential forest permanence contributors to consider:
  - Whether an area was historically forest
  - Climate-related risks such as temperature shifts, drought, other disturbances
- **Are there models already developed for the Chesapeake region that could provide this information?**

Fragmentation Analysis - CLEAR Methods

- MFTS utilized University of Connecticut's Center for Land Use Education and Research (CLEAR) methods for forest fragmentation.
  - Vogt, P., K. Riitters, C. Estrenguil, J. Kozak, T. Wade, J. Wickham. 2007. Mapping spatial patterns with morphological image processing. Landscape Ecology 22: 171-177
- Reclassifies input land use/land cover data into three categories:
  - forest features
  - fragmenting features (i.e. residential and commercial development, agricultural operations, utility corridors)
  - non-fragmenting features (i.e. water/wetlands)*
- **Are there features we want to consider non-fragmenting?**

Figure 7. Classification and distribution of forest types from 2018 conditions in one area of Frederick County, Maryland.

*MFTS fragmented based on anything not identified as forest, as it would have been at least 1-meter distance

Fragmentation Analysis - CLEAR Methods

The forest fragmentation tool classifies forests in four general categories:

Class	Class Name	Class Description
1	Patch Forest	small isolated fragments of forest that are surrounded by non-forest features and completely degraded by "edge effects"
2	Edge Forest	forest pixels along the exterior perimeter of a forest that are degraded by "edge effects" (for example the forest immediately along a major highway or large agricultural field)
3	Perforated Forest	forest pixels along the edge of an interior gap in a forest that are degraded by "edge effects" (for example the forest immediately surrounding a small house lot in the middle of the forest)
	Core Forest	forest pixels that are not degraded by "edge effects" and are relatively far from the forest-nonforest boundary. The Landscape Fragmentation Tool further divides these by size.
4	Small core	smaller than 250 acres
5	Medium core	between 250 and 500 acres
6	Large core	larger than 500 acres

- **What is an acceptable edge width? UConn assumes 100m generally, used in MFTS**

Image from UConn CLEAR Website: Forest Fragmentation

Fragmentation Analysis - Land Use/Land Cover Review

- Land Use/Land Cover Classes Included:
  - Forest
  - Harvested Forest Barren
  - Harvested Forest Herbaceous
  - Tidal Wetlands Forest
  - Riverine Wetlands Forest
  - Terrene Wetlands Forest
- Tree Canopy outside of forests was NOT included:
  - TC over Impervious (Roads, Structures, and Other Impervious)
  - TC over Turf Grass
  - Tree Canopy Other
  - Wetlands Other TC (Tidal, Riverine, Terrene)
- **Based on updated classification, which 2024 edition classes should be used?**

Figure 7. Classification and distribution of forest types from 2018 conditions in one area of Frederick County, Maryland.

Chesapeake Bay Land Use/Cover Classification (2024 edition, 56 classes)

Water and Water Margins

- 10 Tidal Waters
- Lentic
  - 11 Lakes & Reservoirs
  - 12 Riverine Ponds
  - 13 Terrene Ponds
- Lotic
  - 14 Streams and Rivers
- Water Margins
  - 15 Bare Shore

Development

- Impervious
  - 20 Roads
  - 21 Structures
  - 22 Other Impervious (Parking lots, driveways)
  - 23 TC over Roads
  - 24 TC over Structures
  - 25 TC over Other Impervious
  - 31 Extractive Impervious
  - 32 Solar Field Panel Arrays (impervious)
- Pervious
  - 26 Tree Canopy over Turf Grass
  - 27 Turf Grass
  - 28 Bare Developed
  - 30 Extractive Barren
  - 33 Solar Field Barren
  - 34 Solar Field Herbaceous
  - 35 Solar Field Shrubland
  - 36 Suspended Succession Barren
  - 37 Suspended Succession Herbaceous
  - 38 Suspended Succession Shrubland

Forest

- Tree Canopy
  - 40 Forest
  - 41 Tree Canopy Other (now Forested Other)
- Open Space (temporary)
  - 42 Natural Succession Barren
  - 43 Natural Succession Herbaceous
  - 44 Natural Succession Shrubland
  - 45 Harvested Forest Barren
  - 46 Harvested Forest Herbaceous

Wetlands

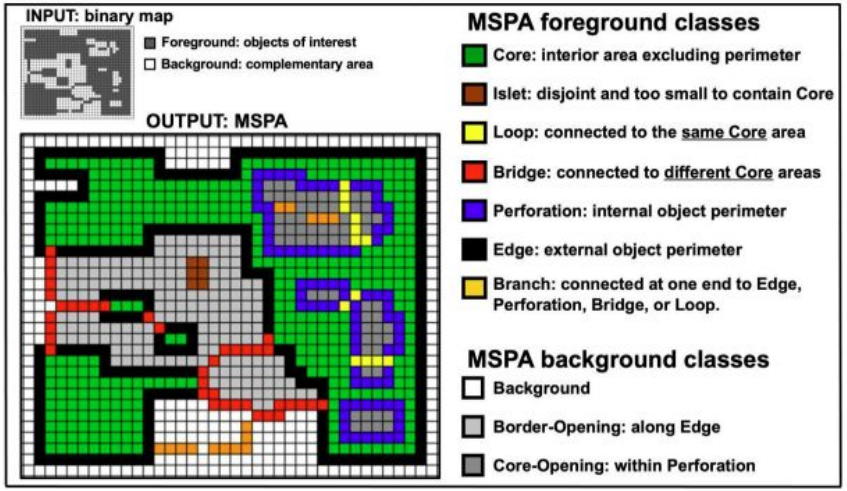
- Riverine
  - 50 Riverine Wetlands Barren
  - 51 Riverine Wetlands Herbaceous
  - 52 Riverine Wetlands Shrubland
  - 53 Riverine Wetlands Tree Canopy
  - 54 Riverine Wetlands Forest
  - 55 Riverine Wetlands Harvested Forest
- Terrene
  - 60 Terrene Wetlands Barren
  - 61 Terrene Wetlands Herbaceous
  - 62 Terrene Wetlands Shrubland
  - 63 Terrene Wetlands Tree Canopy
  - 64 Terrene Wetlands Forest
  - 65 Terrene Wetlands Harvested Forest
- Tidal
  - 70 Tidal Wetlands Barren
  - 71 Tidal Wetlands Herbaceous
  - 72 Tidal Wetlands Shrubland
  - 73 Tidal Wetlands Tree Canopy
  - 74 Tidal Wetlands Forest
  - 75 Tidal Wetlands Harvested Forest

Agriculture

- Productive Lands
  - 80 Cropland Barren
  - 81 Cropland Herbaceous
  - 82 Orchards and Vineyards Barren
  - 83 Orchards and Vineyards Herbaceous
  - 84 Orchards and Vineyards Shrubland
  - 85 Pasture and Hay Barren
  - 86 Pasture and Hay Herbaceous

Analogous classes previously included in forest patch designation

Updated Methodology Options



Output overview from MSPA guide

Landscapemetrics

- Widely cited R package that identifies similar features, e.g. core and edge areas, based on user-specified methods and parameters
- Includes built-in tools for additional class-, patch-, and landscape-level metrics

MSPA (Morphological Spatial Pattern Analysis)

- Newer version of CLEAR tool that can be run using ArcGIS, QGIS, or R
- Includes capability for additional landscape features

Key Advantages:

- Both tools provide increased scalability and/or more robust outputs compared to original CLEAR tool
- Use of updated software platforms provides simpler integration into subsequent analysis workflows

Additional Methodology Options - graph network

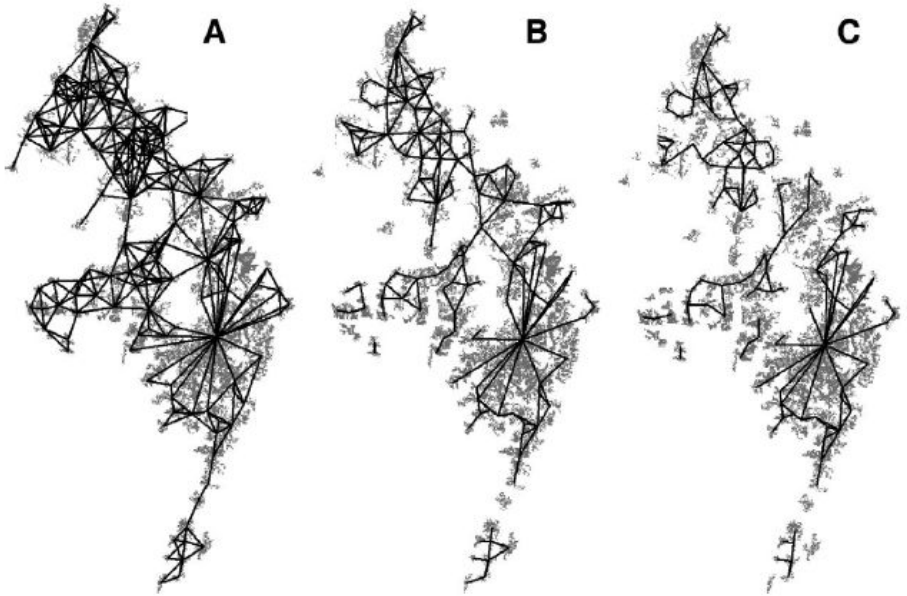


Figure 2. Graph theoretic representation of 138 potential habitat patches for the Delmarva fox squirrel (*Sciurus niger cinereus*) and their connections based on simulated dispersal events. For each patch, 100,000 dispersers were 'released' and successful transfers from source to destination patches were tracked. Figures represent different thresholds of connectedness as determined by inter-patch flux rates; two patches are assumed to be connected if the flux rates are above these thresholds. The flux rates are (A) > 0; (B) > 1000; (C) > 2000.
Source: Data courtesy of T. Lookingbill.

- Generates a network of connections and interactions between patches
- Can provide additional information about landscape connectivity and relative importance of patches
- Example metrics: patch density, number of linkages, centrality to other patches
- **Would this type of additional connectivity information be helpful to users of this analysis?**

Example graph network from Kupfer, 2012