Tree Canopy Change Analysis Memo

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One of Maryland's important environment goals is to maintain and expand its tree cover. Trees provide countless benefits including, carbon sequestration, wildlife habitat, stormwater mitigation, and improved air and water quality. In order to achieve Maryland's tree canopy goal, understanding where the tree canopy losses and gains are currently happening is important so targeted, effective policy decisions can be made.

The Chesapeake Conservancy has mapped tree canopy change from 2013/14 to 2017/18 in several of Maryland's counties using 1x1 meter resolution land cover data. The Maryland DNR Forest Service was given this data with the goal of finding out where the loss is happening, what are the drivers of the loss, how much of the loss is permanent, and what are the patterns between counties and regions. The data includes tree canopy loss and gain from 10 Maryland counties: Prince George's, Montgomery, and Anne Arundel in the Baltimore-Washington Corridor; Calvert, Charles, and St. Mary's in Southern Maryland, and Dorchester, Somerset, Wicomico, and Worcester counties on the Lower Eastern Shore (Figure 1).

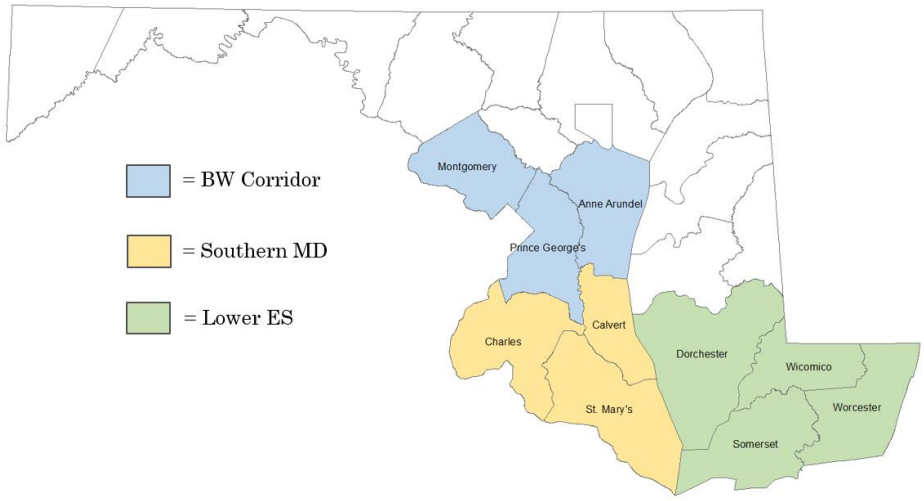

Figure 1 A map of the counties analyzed

When summarizing the area of gain and loss by county and in 100ft stream buffers and critical areas, several patterns begin to emerge (Table 1). In the Baltimore-Washington Corridor and Southern Maryland, each of the counties experienced more tree canopy loss than gain from 2013/14 to 2017/18, while the counties on the Lower Eastern Shore experienced more gain than loss. Both Montgomery and Prince George's counties each had over 6,000 acres of tree canopy loss, almost twice as much as Worcester, the county with the next highest amount of loss. Prince George's and Montgomery counties are very urbanized and densely populated as they surround Washington D.C., which could explain the higher amounts of loss. Urban trees often experience more threats from invasive species and other human caused problems. Looking at the totals for all 10 counties, 100ft stream buffers saw more tree canopy loss than gain, while Critical Areas (area within 1,000 feet of the mean high-tide line of streams and rivers) saw slightly more tree canopy gain than loss. An important note here is that tree canopy gain takes several years to be recognized by remote sensing, while tree canopy loss can be detected instantly.

Table 1 Summary of tree canopy loss and gain. Blue = Baltimore-Washington Corridor, Yellow = Southern Maryland, Green = Lower Eastern Shore

	Tree Canopy Gain (acres)				Tree Canopy Loss (acres)				Total Tree Canopy in 2013 (acres)
County	Total	In Urban Areas	In 100ft Stream Buffers	In Critical Areas	Total	In Urban Areas	In 100ft Stream Buffers	In Critical Areas	
Anne Arundel	188.24	91.01	5.33	78.68	2,543.78	1,860.08	83.04	425.51	165,806
Montgomery	656.14	395.08	52.06	-	6,364.05	4,807.08	666.69	-	174,906
Prince George's	518.15	235.95	23.42	44.38	7,567.04	5,397.82	649.29	334.24	185,014
Calvert	899.24	267.05	24.29	117.67	1,566.72	643.00	28.28	134.22	90,896
Charles	1,478.35	197.91	69.31	65.89	2,529.30	634.85	66.38	87.19	200,761
St. Mary's	1,524.98	249.39	75.11	266.67	1,897.06	318.22	42.82	208.71	137,766
Dorchester	2,111.68	33.65	151.91	517.18	1,730.68	26.35	68.92	429.74	119,822
Somerset	4,778.99	43.09	123.04	626.04	1,258.22	17.18	44.45	123.11	93,353
Wicomico	3,703.89	481.81	157.95	206.13	2,337.47	288.33	76.60	181.30	120,061
Worchester	6,900.44	36.71	587.63	350.19	3,514.53	119.08	226.46	193.86	165,844
TOTAL	22,760.11	2,031.66	1,270.03	2,272.83	31,308.86	14,111.98	1,952.93	2,117.86	1,454,229

We broke down the patches of tree canopy loss into the following size classes for further analysis: less than 0.025 acres, 0.025 to 0.25 acres, 0.25 to 1 acre, 1 to 5 acres, 5 to 10 acres, and over 10 acres (Figure 2). Our reasoning for this was that the size of loss is likely related to its cause; smaller patches of loss would be more likely be caused from things like disease or storms, while larger patches of loss would more likely be from development or forests harvests. The counties in the Baltimore-Washington Corridor experienced a vast majority of their tree canopy loss in patches under 0.25 acres, while

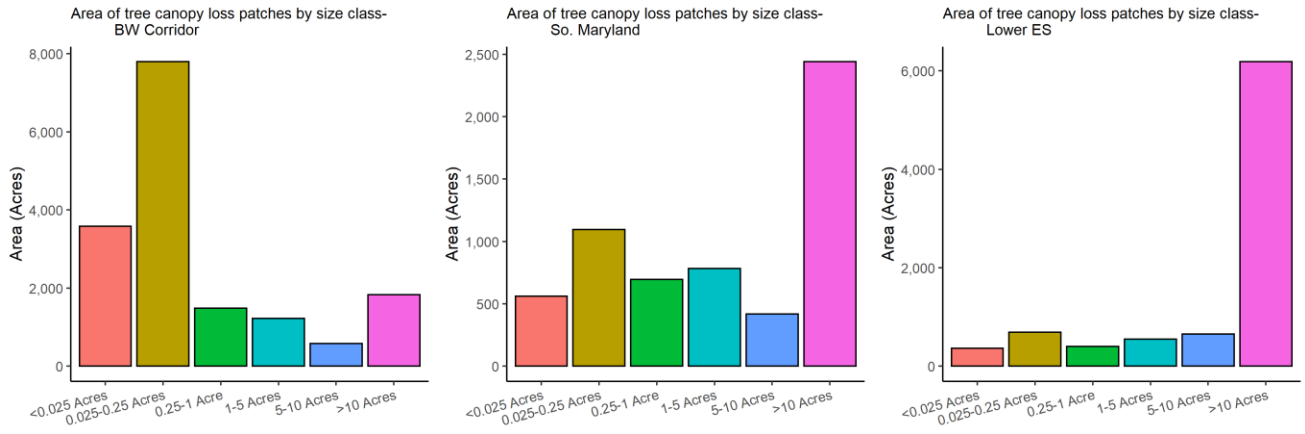

Figure 2 Area of tree canopy loss by size of the loss patch

Southern Maryland and the Lower Eastern Shore have most of their losses happening in patches over 10 acres. Southern Maryland saw a very similar amount of loss over 10 acres when compared to the Baltimore-Washington Corridor (note the different y-axes), however it also saw far less losses in the smaller size classes.

To better understand the patterns shown in figure 2, we took the tree canopy loss data classified by size of loss and looked at what was the land use before the tree canopy loss happened using the Chesapeake Conservancy's 1x1 meter 2013 land use data (Figure 3). The Baltimore-Washington Corridor area has large amounts of loss from tree canopy over turf and tree canopy over impervious surfaces in the 0.025-0.25-acre category. This likely is coming from urban and residential areas, where one sees more trees over roads (impervious surfaces) and lawns (turf). This region also saw more loss in smaller patches (under 0.25 acres) happening in forests compared to the other regions. This could be because these counties are more urbanized and therefore have less healthy forests.

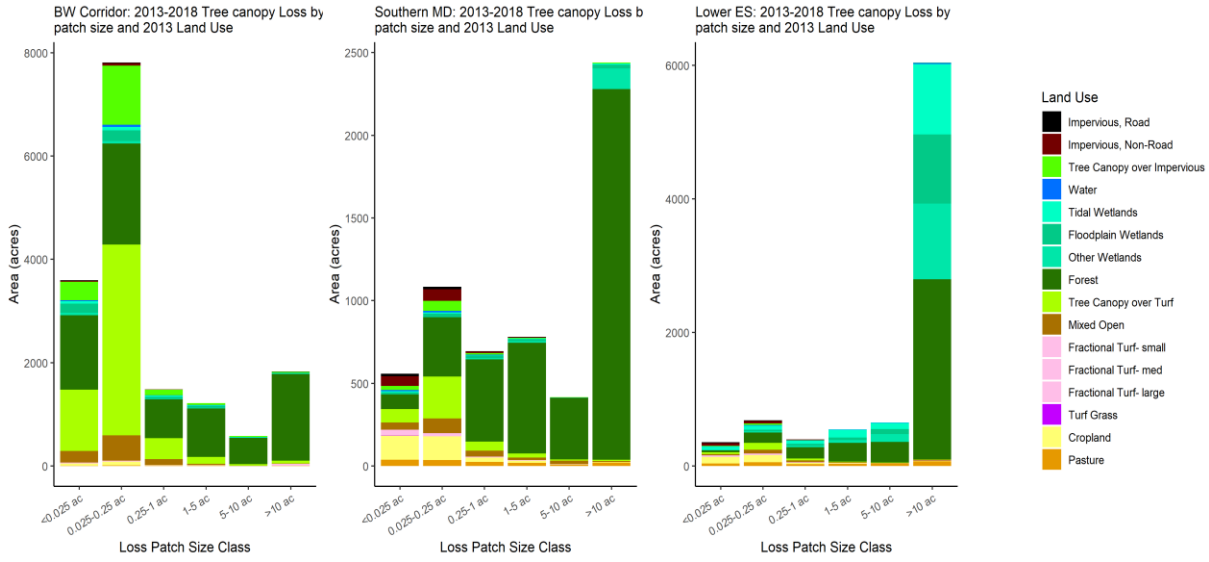

Figure 3 Tree canopy loss by size of loss patch and land use before loss for the three different regions. Note the different y-axes

Vast majority of the losses happening on the Lower Eastern Shore are coming from wetlands and forests patches over 10 acres. This is likely from forest harvests on a rotation, which is common on the Eastern Shore. A large portion of the areas classified as "wetlands" on the Eastern Shore are forested and safely harvested regularly. Forest harvests are not considered actual loss, as the trees grow back. The relatively low amount of loss happening as small patches (<0.25 acres) in forests on the Lower Eastern Shore compared to the Baltimore-Washington Corridor could be a result of younger, healthier forests with more active management.

Southern Maryland seems to be between the Baltimore-Washington Corridor and the Lower Eastern Shore for patterns of loss. Most of the loss is from forests in larger patches, similar to the Lower Eastern Shore. However, there is more loss happening as smaller patches in forests and tree canopy over turf compared to the Eastern Shore. This could be because Southern Maryland is more urbanized than the

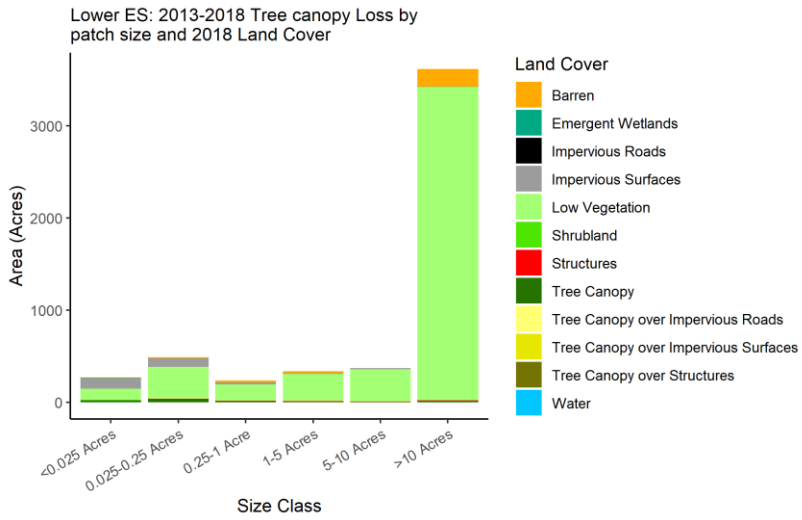

Figure 4 Tree canopy loss by size of loss patch and land cover after loss.

Eastern Shore (not as much as the Baltimore-Washington Corridor, though) and therefor has more urban/residential trees and potentially less healthy forests.

We also did the same analysis but with current land cover (Figure 4). This shows what the areas that experience tree canopy loss look like after the loss and whether the loss is permanent. The 2018 land cover data was only available for three counties at the time of the analysis: Dorchester, Somerset, and Wicomico.

Almost all the tree canopy loss experienced in these three counties is now classified as "low vegetation" which suggestions that the loss might not be permanent, as low vegetation can be reforested. The fact that most of the tree canopy loss that happened in patches over 10 acres is now low vegetation suggests that these losses could be from forest harvests. If it was development, the land cover would include more impervious surface like roads and structures. Timber harvesting is quite common in these counties on the Lower Eastern Shore and is not a true loss as the trees grow back.

We also investigated how much of the loss was from natural forest dynamics. To estimate which loss patches were potentially due to natural forest dynamics, we isolated all loss patches under 1,000 m^2 that intersected forests and looked at the land use in the surrounding 30 meter buffer. If that buffer was over 90% forested based on the Chesapeake Conservancy's 2013 land use data, then the patch was classified as interior forest loss. Patches with 10-90% forest in the buffer were classified as forest edge loss (Table 2).

Prince George's and Montgomery counties saw high amounts of tree canopy loss in the forest interior and edge. As mentioned earlier, these counties are extremely urbanized, and are likely to have forests more plagued by

Table 2 Area of tree canopy loss patches under 1,000m2 in forest edge and interior. Blue = Baltimore Washington Corridor, Yellow = Southern Maryland, Green = Lower Eastern Shore

	Area of Natural Canopy Gap (acres)		Total Area of Forest (acres)	Total Area of TC Loss (acres)
County	Edge	Interior		
Anne Arundel	252.70	29.42	102,356	2,543.78
Montgomery	1,360.30	404.56	93,500	6,364.05
Prince George's	1,608.96	542.63	120,878	7,567.04
Calvert	262.86	13.56	73,493	1,566.72
Charles	225.66	48.32	178,593	2,529.30
St. Mary's	163.34	16.80	116,704	1,897.06
Dorchester	67.44	3.98	108,897	1,730.68
Somerset	45.18	3.30	85,485	1,258.22
Wicomico	114.25	11.62	106,418	2,337.47
Worcester	73.54	12.17	153,879	3,514.53
TOTAL	4,174.22	1,086.34	1,140,203	31,308.86

invasive species and human encroachment that forests in less densely populated areas. An important note is that loss along the forest edge could be for trees dying from storms, disease, or other natural causes, but could also be from development slowing encroaching into the forests. In addition to this, just because a canopy gap is "natural" does not mean it's desirable- it could be due to unhealthy forest conditions.

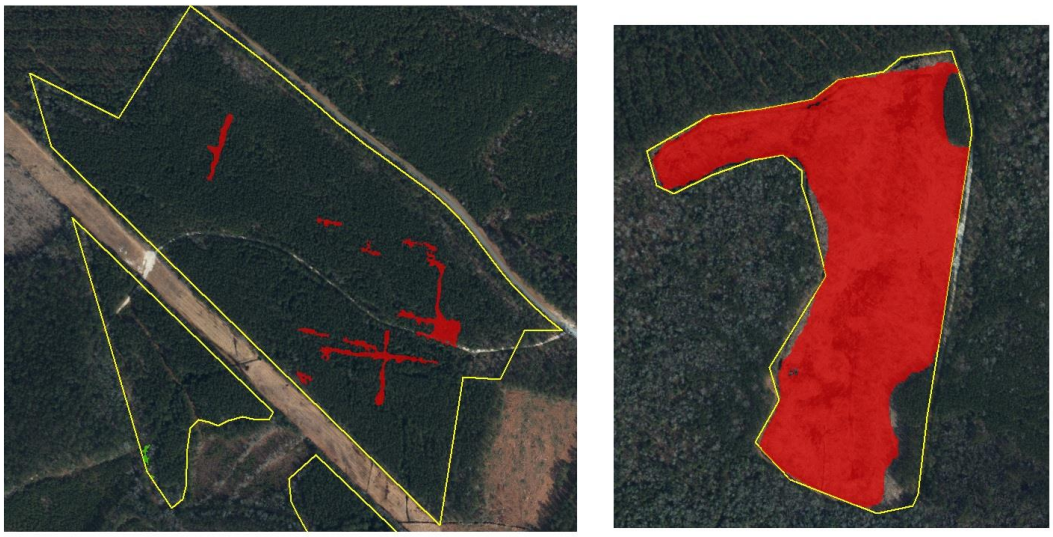

Figure 5 Two harvests (outlined in yellow) in Wicomico county and the tree loss detected in them (red). The picture on the left is of a thinning in 2015 and the picture of the right is of a regeneration harvest in 2016

Timber harvests can show up as tree canopy loss even though they are not actual loss as the trees will grow back. Quantifying how much tree canopy loss is from silvicultural activities can help provide a more realistic picture of what the actual tree canopy loss is. Most of the forest harvesting in Maryland happens on private lands, so there often is not explicit spatial data. However, there is spatial data available for harvest on State Forests. In addition to this there is data that quantifies the area of forest harvested in each county. However, that value will not represent the amount of detected tree canopy loss from forest harvest exactly. The type of harvest impacts how the tree canopy change data shows up. In figure 5, the picture on the left is of a thinning (yellow) from 2015 and the tree canopy loss detected (red) is only showing up in small patches because only a few trees were removed. On the other hand, the picture of the right shows a regeneration harvest (yellow) from 2016 where only a few trees were left to provide seed for the next timber rotation. The patch of tree canopy loss (red) almost fits perfectly into harvest outline.

Based on our analysis, we think the following are useful things to consider/ produce when interpreting tree canopy change data:

- A graph of area of tree canopy loss by size of the loss and the land use right before the tree canopy loss
    - This helps determine where the loss is happening (urban/residential areas vs larger patches of forests) and at what scale. Small loss patches more likely to be from death or removal, while larger patches of loss are more likely caused by forest harvesting or clearing for development.
- A graph of area of tree canopy loss by size of the loss and the land use/cover after the tree canopy loss

    - This shows what the loss looks like now and whether the loss is permanent. Tree canopy replaced with impervious surfaces it is likely a permanent change, while tree canopy replaced with low vegetation is not permanent.
- A table summarizing the area of small patches (under 1,000 m^2) of tree canopy loss that touch forests, specifying between forest interior and edge
    - This estimates how much of the tree canopy loss is natural forest dynamics, although losses on the forest edge could be from encroaching development. It also helps quantify the relative health of the forests.
- Information about the amount and type of forest harvesting in that area/ spatial data for harvests if available.
    - Forest harvests are not tree canopy loss so quantifying how much of the detected loss is actually from forest harvesting will provide a more realistic picture of how much real loss there is.
    - The type of forest harvest impacts how tree canopy loss will be detected.
- Local knowledge about the area being analyzed.
    - Knowing how urbanized the region is or how common forest harvests are can provide important context to the results.

Simply looking at the total values of tree canopy loss and gain does not provide a complete picture of what is happening to tree canopy. Looking at where the loss is happening, what is causing the loss, and estimating how much of it is permanent provides important context to the data and highlights where conservation work should be focused.