Recommendations for improving the modeling of forest harvest in Phase 7 of the Chesapeake Bay Program's watershed model

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Summary

The Timber Harvest Task Force was convened in early 2023 by the Forestry Workgroup and Land Use Workgroup to improve the mapping and modeling of forest harvest activities in the watershed. The Task Force was convened by the USFS and includes representatives from all watershed states, USGS and other partners (see Appendix A for full membership list). The Task Force identified multiple opportunities to improve modeling of the water quality impacts of forest harvesting in the Phase 7 Watershed Model and is putting forward the following recommendations:

- **Harvested forest land use duration and loading rates**: After a harvest, land should continue to load as harvested forest for three years (it currently only stays in harvest for one year). Loading rate ratios for TN and TSS for harvested forest should also be corrected to align with the originally recommended loading rates for Phase 6 (TN= 7.03, TSS= 3.05**)**.
- **Harvest forest default rate**: For states that don't report permitted harvested forest acres during annual Progress reporting, the default rate for harvested forest should be changed from 1.5% of true forest to 1.1% of true forest.
- **Reconciling reported and mapped harvest data**: To avoid double-counting of clearcuts, county-scale data reported by states should be spatially allocated to the mapped harvested forest footprint up to the amount reported. Any additional reported acres (above the mapped acres) will be distributed across NHD catchments within each county based on the relative amount of "harvestable" forest in each catchment, which will be defined as forest patches >10 acres.

The group also developed recommendations to increase the efficiency of forest harvesting BMPs for TN removal. Those findings and recommendations are presented in a separate report (Cinalli et al., 2024).

Harvested forest land use duration

When the Bay Program completed the last major update to CAST (for the Phase 6 model), Maryland Forest Service conducted a review to establish loading rates for harvested forest. Based on this review, loading rate ratios established the loads from harvested forest relative to true forest.

Table 1: Loading rate ratios for harvested forest based on data review by Justin Hynicka, MD DNR (2015)

	TN Loading Rate Ratio	**TP Loading Rate Ratio**	**TSS Loading Rate Ratio**
True Forest	1	1	1
Harvested Forest	7.03	3.12	3.05

However, when the Phase 6 loading rates were established, a slightly different loading rate ratio was established for TN and a much different loading rate ratio was established for TSS (Chesapeake Bay Program Phase 6 Watershed Model Documentation- Section 2). These modified loading rates appear to be erroneous in the Phase 6 model based on consultation with the modeling team. The Timber Harvest Task Force is therefore recommending correcting the loading rates for TN and TSS to align with the original recommendations from Hynicka (2015).

Table 2: Loading rates and loading rate ratios for harvested forest in CAST documentation

	TN Loading Rate Ratio	TN Loading Rate (lbs/acre/yr)	TP Loading Rate Ratio	TP Loading Rate (lbs/acre/yr)	TSS Loading Rate Ratio	TSS Loading Rate (lbs/acre/yr)
True Forest	1	1.68	1	.08	1	.07
Harvested Forest	7.07	11.88	3.12	.24	10	.6

At the same time, the loading rate ratios calculated by Hynicka (2015) represented average increases in loading for the three-year period following a harvest. However, the model currently only applies this increased loading rate for one year prior to reverting the land to true forest loading rates. The Timber Harvest Task Force confirmed that it is reasonable to expect that a harvest could impact water quality for three years following a harvest and that the harvested forest land use loading rates should therefore be applied for a three-year period following a harvest. Functionally, this will mean that in any given year, the harvested forest land use in CAST will include land that has been harvested in the last three years.

Harvested Forest Default Rate

As part of the annual progress reporting for the Bay Program, states are asked to provide their annual permitted harvested forest acreage for the reporting year. However, some states do not have permitting data for forest harvests on private lands, and therefore do not have an accurate accounting of harvested forest acres. For states that do not track permitted forest harvest acres or do not report in a given progress year, a "default rate" is applied. The default rate assumes that 1.5% of all true forest in the state is harvested that year. However, this rate is much higher than the relative amount of harvested forest to true forest that we are mapping in the watershed.

To re-evaluate the accuracy of the current default rate, the Timber Harvest Task Force worked with the Forest Inventory and Analysis (FIA) program at the USFS to produce estimates of the amount of true forest and harvested forest at the state and watershed scale. State data was clipped to the watershed boundary. The inventory identifies plots with "cutting" treatments, which are defined as the removal of one or more trees from a stand, with the treatment affecting at least one acre. The inventory therefore includes both clearcuts and more selective harvests as cutting treatments.

FIA also only samples a subset of plots annually, with most states in the watershed being on a 7-year cycle, except for VA which is on a 5-year cycle. Therefore, to derive an annual estimate of the % of forest that is harvested, we divided the total % cut by the cycle length for each state, and used the average cycle length for the watershed estimate. FIA was also able to produce an annual estimate of the % of

forest that is harvested using the remeasurement period at the plot level, which is expected to be a more accurate approach.

TABLE 3: FIA ESTIMATES OF THE % OF FOREST HARVESTED ANNUALLY

Geography	total % cut/cycle length	annual % cut estimates (based on remeasurement period)
CBW	1.06%	1.11%
DE	0.76%	0.89%
MD	0.30%	0.38%
NY	1.41%	1.90%
PA	1.00%	1.20%
VA	0.89%	1.09%
WV	0.55%	0.65%

Given the variation in harvest rates across the watershed, the Timber Harvest Task Force discussed whether to identify state-specific default rates. However, since FIA estimates are more accurate at larger spatial scales when there are a sufficient number of plots, we did not have confidence in the state-level estimates within the watershed for states that have a relatively small land area in the watershed. We therefore decided to recommend maintaining a watershed-wide default rate. Based on the FIA estimates (Table 3), the Timber Harvest Task Force is recommending reducing the default rate from 1.5% of true forest to 1.1% of true forest.

Reconciling reported and mapped harvest data

Currently the Bay Program uses both reported and mapped forest harvests to quantify the amount of harvested forest in CAST. For states that report their harvested forest acres as part of the annual progress reporting at the county scale, these acres are proportionately allocated to sub-county modeling units (land-river segments or LR Segs) based on the relative amount of "true forest" within each unit.

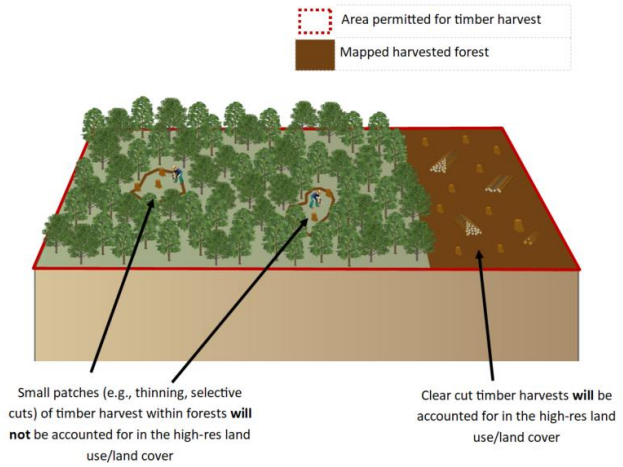

FIGURE 1: GRAPHIC DEPICTION OF FOREST HARVESTS LIKELY TO BE DETECTED IN THE HIGH-RES LAND USE/LAND COVER DATA. GRAPHIC CREDIT: JACKIE PICKFORD, USGS

States that don't report harvest forest acreage have the default rate applied proportionately based on the distribution of true forest across LR Segs. In both cases, the reported acres or the default acres are removed from the true forest and modeled as harvested forest. Since we do not know precisely where these harvests are occurring, it is also likely that some harvests are being allocated to LR Segs where there is minimal harvest activity (for example, more urban areas that only have small forest patches).

USGS also maps forest harvests every 4-5 years and interpolates for intervening years, but the aerial imagery is only able to detect clear cuts and more intensive harvests (Figure 1). These

mapped harvested forest acres get modeled as “mixed open” in CAST and are also subtracted from the true forest footprint. This effectively means that some of these harvest acres are currently getting subtracted from true forest twice in the model.

To evaluate whether it would be viable to rely exclusively on the mapped harvest data to avoid the double-counting issue and reduce reporting requirements, we developed an approach to estimate the % of total harvest acres likely to be captured in the high-resolution land use/land cover data. Using FIA data on basal area (a measure of stand density) within plots before and after harvest, we developed estimates of the amount of total harvests that transitioned the forest from a higher stand density to a very low stand density. We expect these more intensive harvests would be more likely to be captured in the aerial imagery and mapped as a harvest. Watershed-wide, only 20.9% of harvests fit the criteria established for a more intensive harvest. We are therefore not likely to be able to accurately account for forest harvesting activities using the land use data alone.

TABLE 4: % OF HARVESTS THAT TRANSITION FORESTS FROM HIGH BASAL AREA TO LOW BASAL AREA, ESTIMATED USING FIA DATA

	% of harvests that are more intensive
CBW	20.92%
DE	32.86%
MD	21.44%
NY	0.00%
PA	8.72%
VA	47.31%
WV	0.51%

To avoid double counting clearcuts and improve the spatial allocation of reported or default harvest acres, the Timber Harvest Task Force is recommending the following approach (see Figure 2 for a graphic depiction/example). States that track permitted harvest acres will continue to report that data to the Program annually at the county scale. The reported data or the default harvest acreage will be allocated to the mapped harvested forest footprint up to the total amount of mapped acres in that county. It is highly unlikely that mapped acres will exceed reported acres giving the limited amount of harvest activity that is captured in the high-res data.

Any additional reported or default acres (above the mapped acres) will be distributed across NHD catchments within each county based on the relative amount of “harvestable” forest in each catchment. “Harvestable” forest will be defined as forest patches >10 acres and will be updated with the high-res Land Use/Land Cover data every 4-5 years. Forest patches <10 acres are unlikely to be harvested as the cost of harvesting is likely to be too high to compensate for the potential financial gains from the harvest. By only allocating harvest activities to forest patches >10 acres, we will improve the spatial allocation of harvest acres to those forest patches that could realistically be harvested.

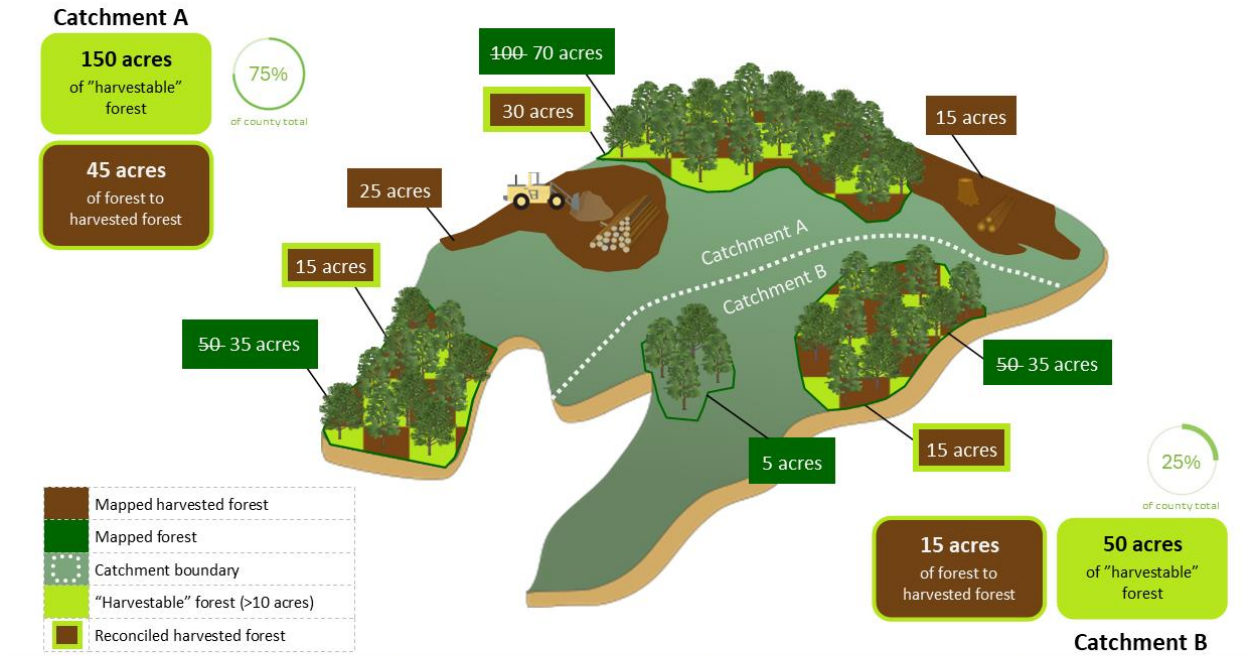

FIGURE 2: GRAPHIC DEPICTION OF PROPOSED APPROACH TO RECONCILE REPORTED AND MAPPED HARVEST DATA. GRAPHIC CREDIT: JACKIE PICKFORD, USGS

Appendix A: Timber Harvest Task Force Membership List

- Katie Brownson, USFS, Coordinator
- Lorenzo Cinalli, USFS
- Peter Claggett, USGS
- Alanna Crowley, MD Forest Service
- Cassie Davis, NY Department of Environmental Conservation
- Rob Feldt, MD Forest Service
- Helen Golimowski, Devereux Consulting
- Anne Hairston-Strang, MD Forest Service
- Matt Keefer, PA Bureau of Forestry
- Terry Lasher, VA Department of Forestry
- Ben Livelsberger, PA Bureau of Forestry
- Sarah McDonald, USGS
- Jeremy McGill, WV Division of Forestry
- Chris Miller, DE Forest Service
- Dave Montali, Tetra Tech
- Caitlin Verdu, VA Department of Forestry