# Sara to do: Total volume provided from BioSum must be transformed into merch volume before use as input to twitchvol (and twitchvolM) equations.

BioSum passes AvgVolPerTree for CT, SL and LL trees but this is TOTAL, not merch volume. Equations (such as for harvesters and forwarders) that are based on volume (or weight) assume merch not total. So, the total average volume per tree for a given size class must be multiplied by, say, SmallLogTreesMerchAsPctOfTotal/100 to get merch vol. It appears that the OpCost programmer did not make adjustments when we switched from the FRCS convention of providing merch volumes to the providing of total volumes (merch bole + tops & limbs), the better to customize handling of chipping costing. As an example, see SKID\_06C, S and L eqns in opcost\_equation\_ref for how these are applied.

# JF decided: Remove cost multiplier on harvester for Ground-based CTL

An undocumented multiplier of 5.00 was in the OC 9.1 code for harvester time on ground-based CTL (but not Cable CTL or helicopter CTL). Having no basis for this multiplier, I am removing it.

# Chainsaw equations

Jeremy decided to separate felling and bucking/limbing by establishing bucking as a separate machine (with no move in costs) applied only to Cable Manual WT/Log and Ground-Based Manual Log. The OpCost 9 programmer had defined a second set of chainsaw equations that were identical to the first but simply added a term to account for bucking and limbing time. We are appropriating that term as our bucking and limbing equation to use where applicable. No documentation or pointer to a source was provided, so we are using these as a placeholder with hopes for something better down the road. Jeremy set these up as tree-size specific (SL or LL; we assume that B&L never occurs on chip size trees which are too small to require this) in the event that when better info is acquired, they need to be. For now, they are the same equation, but applied to tree size specific TPA inputs.

# Size specific modifications

Concept: Jeremy sees no compelling evidence that costs can’t be summed by parts, for example, for different size ranges of trees. This was one reason for the BioSum, FRCS and OpCost architecture if BC, CT, SL and LL trees. Inputs such as dbh and twitchVolM (for feller-buncher eqns) and treesRemoved (used extensively in the units equations) all enter their equations in a fashion such that they can be specific to a tree size class and then the results for all tree size classes can be summed to get the total machine time required. Some, such as chipFeedstockWeight (used for the chipping equation that is NOT based on DBH) can be size specific or done as a combined calc on the sum of all weight to be chipped. This granularity in calculation is important so that, for example, in mechanized systems, the machines can be assumed for use only on cutting CT and SL, and chainsaws assumed for LL trees. Also, we don’t want the stroke boom delimber costed as if it were processing CT as these are processed via chipper

# Chipping considerations

Concept: 2 vs 1;

# Drop Shovel

The harvest system table for OC10 shows no shovel specific equation. It shows two rows for machine feller-buncher, with the same equations (2 and 7), but a “shovel” entered for machinecost in one of them. In the cost table, the $/PMH for shovel is 186 vs 210.1 for feller buncher, but it defies logic that we would use the FB equations to represent machine time needs for the shovel. Jeremy proposes dropping this system unless and until better info is available.

# Misrepresented and missing loaders

Some harvest systems (e.g., cable CTL, helicopter CTL) currently have no provision for a machine to load logs onto trucks, unless a magical yarder drops them from the sky into the bed of the truck. For these, we could assume the use of the stroke boom delimber (inaccurately labeled sideboom processor SBP), but that seems less than ideal in that the equations we are using for that machine assume that it is used to delimb, buck and load, so would be overstating the cost of loading these already limbed and bucked logs. Another option would be to use the Forwarder used as loader equation from Petitmermet for these cases. Probably the Forwarder as loader makes most sense to account for loading costs of what are already logs, and the Stroke boom delimber for cases where whole trees (SL or LL; CT don’t matter given they don’t get loaded onto log trucks) are delivered to the landing. Note that where there is a forwarder as part of a system already, the loading cost is accounted because “unloading time” was one of the cycle elements considered when the equation was developed for FOR\_06.

# Units- null means PMH

In the OpCost\_equation table, when units are not specified, the result of the eqn is already in PMH (Productive machine hours)

# Helicopter Manual WT mis-described

As defined in OpCost, it is a whole tree system; the FRCS text field description however specifies limbing and bucking. It is not plausible that one would bring limbs or whole trees out by helicopter, so it appears that the description in FRCS is likely accurate and the label (WT) is not. It should be relabeled Helicopter Manual in BioSum and OpCost (in all relevant places). Equation selection will assume Manual (NOT WT).

# Loading CT material into the chipper

We assume that Forwarders and Skidders can do this without extra cost; Yarders cannot, so must be paired with a stroke-boom delimber or a forwarder used as loader.

# Sara: Move-in cost

It is unclear how move-in cost gets calculated under OC10. OpCost input contains move-in hours (time to get from base to harvest operation) and the assumed harvest area. OpCost harvestsystem ref contains a move-in multiplier (0.6533/assumed harvest area) and a MoveInCostLowBoy (always MoveInHours \* 200 or 300, divided by Assumed harvest area). Hard to know why it is sometimes 300 and sometimes 200—there is no apparent pattern.

# JF Decided: Remove Undocumented cost multiplier on Ground-Based Manual Log (2.5) since not documented.

# baFracCut implementation

Lesley is adding baFracCut as the proportion (0-1) of basal area cut in the next version of BioSum (to appear as a new column in the Opcost\_input table). This will allow us to use SAW\_06 and SKID\_09 with something other than a crude default assumption. It is now implemented in opcost\_equation\_ref entries for these equations but until BioSum is updated, the OpCost R code will need to set baFracCut to a value such as 0.5 so that it will not be missing and cause crashes or corruption.

# JF ToDo: HarvestMethod table will need review and revision

Tethered needs a max slope entered of 90. Min tpa and min vol need to be re-evaluated in light of the change that calculates costs separately for each size class of tree. Are these minimums necessary or counter-productive?

# Sara Question: In OpCost\_harvestsystem\_ref, Do we need different machine names for the different size classes of trees?

Or just different Eqn IDs and units? And is it still helpful to have a separate units table, given that we will have to duplicate a units row for each size class? Or should that part of the eqn be folded into the one in the equation\_ref table?

# Handling intensity (for the two equations that use it)

Lesley will add an intensity column (0 to 1) in the OpCost input table. We need to process -1 values (indicating missing FVS\_SUMMARY table or records) by ruling out the equation for those cases. SARA: Will FVS\_Summary always be created? Answer: No—only if user requests.

# Sara ToDo: Replace “Slide-boom processor” with “Stroke boom delimber”

Rob says the term has not been used in 25 years. Need to change SBP to SBD throughout also.

# Caution with turn time minutes and eqn YARD\_07

The units for this equation have small and large log trees combined. If size classes are going to be handled separately, will need to make units for YARD\_07S contain only Small.log.trees.per.acre and YARD\_07L contain only Large.log.trees.per.acre

# Caution with spelling of variable names

There is some trickiness among chip, small and large log trees among tpa, avg vol, density, etc. to watch out for in that capitalization, plurality and punctuation are not completely consistent among these.