Formula Descriptions

This document shows all of the variables that are used in the Net Present Value analysis of managing an individual maple tree for sawtimber production or leasing it for syrup production. The first section shows all of the variables that are directly controlled by the user, the second section displays the intermediate formulas that are used in the analysis, while the third section outlines all of the formulas that are used in the final analysis.

Section 1. User Controlled Variables

All of the variable in this section are directly controlled by the user. The possible inputs/ranges for each of the variables are displayed in red with recommended values for some of the variables placed in parentheses.

Initial tree diameter (ITD)   6 - 36   inches (dbh)
Height of tree affected by tapping (HTTap)   3-12 (8) ft
Initial merchantable height   (IMH) 8- 48 (32) ft
Initial Merchantable height growth rate Untapped (IMHGU)   0 – 3 (.5) ft/year
Reduction in height growth due to tapping (%ΔHGT) 0-50 (10) %
% Decline in annual height growth rate 0-5 (1) % (%ΔAHGR)
Initial Diameter Growth Rate Untapped (DGRU)   0 – 1 (.15) inches/year to dbh
Reduction in diameter growth due to tapping (%ΔDGT) 0-50 (10) %
% Decline in annual diameter growth rate 0-5 (1) % (%ΔADGR)
Species   sugar or red maple (Sp)
Real Annual % increase/decrease in stumpage rate (%ΔSR) -10 to 10 (4.5) %
Annual Lease Payment (ALP) 0 – 2 (.50) $/tap/year
Real Annual % Increase/Decrease in Lease Payment (%ΔLP)   -10 to 10 (0) %
Diameter at which the tree can be tapped (D1T) 6-12 (10) inches (dbh)
Diameter at which to add a second tap (D2T) 12-36 (18) inches (dbh)
Discount rate (DR) 0-16 (4) %
Number of trees per acre (TPA) 30-500 (100) # trees/acre
Regular taxes per acre (RTPA) 0-1,000 $/acre/year
Ag assessment taxes per acre (AgTPA) 0-1,000 $/acre/year
Time horizon of investment period (THIP)   2-40   years
Log Scale (LS)   Doyle or Scribner or International scale
Number of Grades reduced by defects in butt log (#GRBL) 0 – 4 (1) grades
Number of Grades reduced by defects in upper logs (#GRUL) 0 – 4 (1) grades
Percentage of Delivered Log Price that the landowner receives (%DLPLR)10-100 (50) %
Value of Tapped Logs as a % of Untapped Logs (TL%UT) 10-150 (33) %
Stumpage rate for Cordwood (SRC) 0-50 (20) $/MBF
Butt Log Market (BLM) sawlog or cordwood or veneer

Sawtimber Delivered Log Prices (SDLP)

DBH Range	Untapped Sugar Maple (SDLPUSM)	Untapped Red Maple (SDLPURM)
less than 10" dbh	SRC	SRC
Between 10 and 12" dbh	0-2,000 $/MBF	0-2,000 $/MBF
Between 12 and 14" dbh	0-2,000 $/MBF	0-2,000 $/MBF
Between 14 and 16" dbh	0-2,000 $/MBF	0-2,000 $/MBF
greater than 16" dbh	0-2,000 $/MBF	0-2,000 $/MBF

Veneer Prices (VP)

DBH Range	Untapped Sugar Maple Veneer (USMV)
Between 14 and 15"	1,000-12,000 $/MBF
Between 15 and 16"	1,000-12,000 $/MBF
Between 16 and 18"	1,000-12,000 $/MBF
Between 18 and 20"	1,000-12,000 $/MBF
greater than 20"	1,000-12,000 $/MBF

Section 2. Intermediate Formulas
The following formulas are based on the variables presented above. They do not appear directly in the final spreadsheet, rather they are used in the final derivations.

Initial Stumpage Table (IST)
The following table shows how stumpage rates are derived based on the user controlled variables provided above. The numbers in each cells are explained in the paragraphs below.

DBH Range	Untapped Sugar Maple (SRUSM)	Untapped Red Maple (SRURM)	Tapped Sugar Maple (SRTSM)	Tapped Red Maple (SRTRM)
Less than 10" dbh	1	2	3	4
between 10 and 12" dbh	5	6	7	8
between 12 and 14" dbh	9	10	11	12
between 14 and 16" dbh	13	14	15	16
Greater than 16" dbh	17	18	19	20

1,2,3,4 = Stumpage Rate for Cordwood (SRC)

5,9 = Sawtimber Delivered Log Price Untapped Sugar Maple (SDLPUSM) * Percentage of Delivered Log Price that the landowner receives (%DLPLR)

6,10,14,18 = Sawtimber Delivered Log Price Untapped Red Maple (SDLPURM) * Percentage of Delivered Log Price that the landowner receives (%DLPLR)

13 = IF (Butt Log Market (BLM)="veneer", AVERAGE(USMV1:USMV2)* Percentage of Delivered Log Price that the landowner receives (%DLPLR),
Sawtimber Delivered Log Price Untapped Sugar Maple (SDLPUSM) * Percentage of Delivered Log Price that the landowner receives (%DLPLR)

17 = IF (Butt Log Market (BLM)="veneer", AVERAGE(USMV3:USMV5)* Percentage of Delivered Log Price that the landowner receives (%DLPLR), Sawtimber Delivered Log Price Untapped Sugar Maple (SDLPUSM) * Percentage of Delivered Log Price that the landowner receives (%DLPLR)

7,11,15,19 =IF(Butt Log Market (BLM)="cordwood", Stumpage Rate for Cordwood (SRC), (Stumpage Rate Untapped Sugar Maple (SRUSM) * Value of Tapped Logs as a % of Untapped Logs (TL%UT)

8,12,16,20 =IF(Butt Log Market (BLM)="cordwood", Stumpage Rate for Cordwood (SRC), (Stumpage Rate Untapped Red Maple (SRURM) * Value of Tapped Logs as a % of Untapped Logs (TL%UT)

Monetary value of increase in lease payment ($ΔALP) = Annual Lease Payment (LP) * Annual % Increase/Decrease in Lease Payment (%ΔLP) = _____ $/tap/year

Untapped stumpage rate increase/decrease of butt log ($ΔUSRBL)
= Initial Stumpage Rate of Untapped Butt Log (ISRUBL) * Real Annual % Increase/Decrease in Stumpage Rates (%ΔSR) = _____ $/MBF/year

Tapped stumpage rate increase/decrease of butt log ($ΔTSRBL)
= Initial Stumpage Rate of Tapped Butt Log (ISRTBL) * Real Annual % Increase/Decrease in Stumpage Rates (%ΔSR) = _____ $/MBF/year

Stumpage rate increase of upper logs ($ΔSRUL)
= Initial Stumpage Rate of Upper Logs (ISRUL) * Real Annual % Increase/Decrease in Stumpage Rates (%ΔSR) = _____ $/MBF/year

Regular taxes per tree (RTPT)
= Regular Taxes per Acre (RTPA) / Trees per Acre (TPA) = _____ $/tree/year

Ag assessment taxes per tree (AgTPT)
= Ag Assessment Taxes per Acre (AgTPA)/ Trees per Acre (TPA) = _____ $/tree/year

Initial Untapped Stumpage Rate Butt Log (IUSRBL) _____
= IF (Species = "red", VLOOKUP ((ITD-(#GRBL*2)),IST,SRURM), VLOOKUP((ITD-(#GRBL*2)),IST,SRUSM)) = _____ $/MBF

Initial Tapped Stumpage Rate Butt Log (ITSRBL)
= IF (Species = "red", VLOOKUP ((ITD-(#GRBL*2)),IST,SRTRM), VLOOKUP((ITD-(#GRBL*2)),IST,SRTSM)) = _____ $/MBF

Initial Stumpage Rate Upper Logs (ISRUL)
= IF (Species = "red", VLOOKUP ((ITD-((#GRUL*2)+2)),IST,SRURM), VLOOKUP((ITD-((#GRUL*2)+2)),IST,SRUSM)) = _____ $/MBF

<u>Diameter Growth Rate Tapped (DGRT)</u>
= Diameter Growth Rate Untapped (DGRU) * % Reduction in Diameter Growth Rate
due to Tapping (%ΔDGT) = _____ inches/year to dbh

<u>Merchantable Height Growth Rate Tapped (HGRT)</u>
= Merchantable Height Growth Rate Untapped (HGRU) * % Reduction in Merchantable
Height Growth Rate due to Tapping (%ΔHGT) = _____ ft/year to merchantable height

<u># of 16 ft logs affected by tapping (#16LABT)</u>
= Height of the tree affected by tapping (HTTap) / 16 = _____ # of 16 ft logs

Section 3. Spreadsheet Formulas

This section used the variables above and intermediate formulas to conduct the final NPV
analyses over a 40 year time horizon. It is based on the Doyle Scale, as the log scale is
the only variable that changes in the final spreadsheet. This section only uses acronyms
in the formulas, so the user mustrefer back to the previous pages to find descriptions of
the acronyms. Using the "Control-F" function on your keyboard will make this process
easier.

Untapped Tree Diameter Year 1 (UTD1)
= ITD

Untapped Tree Diameter Year 2 (UTD2)
= UTD1 + (DRGU * (1-(%ΔADGR))^(Current Year-Year 1))

Tapped Tree Diameter Year 1 (TTD1)
= ITD

Tapped Tree Diameter Year 2 (TTD2)
= TTD1 + (DRGT * (1-(%ΔADGR))^(Current Year-Year 1))

Number of 16 Foot Logs Untapped (#16LU)
= (IMH/16) +((IMHGU/16)*(1-%ΔAHGR)^(Current Year-Year 1))

Number of 16 Foot Logs Tapped (#16LT)
= (IMH/16) +((MHGT/16)*(1-%ΔAHGR)^(Current Year-Year 1))

*Board Foot Volume Equations: The following three formulas utilize the same two
variables (#16LU and UTD), their only difference is in the coefficients for the volume
equation.*

Board Ft Volume of the Entire Tree Untapped; Scribner Scale (BFVETUSS)
=((17.53508*(#16LU))+(0.59242*(#16LU ^2))-22.50365)+(((3.02988-(0.02302*(#16LU
^2))-(4.34391*#16LU))*UTD))+(((((0.51593*#16LU)-(0.02035*(#16LU ^2))-
(0.01969))*(UTD^2)))

Board Ft Volume of the Entire Tree Untapped; International Scale (BFVETUIS)
=((1.52968*(#16LU ^2))+(9.58615*E156)-13.35212)+(((1.7962-(0.27465*(E156^2))-(2.59995*E156))*$C156))+(((0.04482-(0.00961*(E156^2))+(0.45997*E156))*($C156^2)))

Board Ft Volume of the Entire Tree Untapped; Doyle Scale (BFVETUDS)
=((0.55743*(#16LU ^2))+(41.51275*#16LU)-29.37337)+(((2.78043-(0.04516*(#16LU ^2)) - (8.77272*#16LU))*UTD))+(((0.04177-(0.01578*(#16LU ^2)) +(0.59042*#16LU))*(UTD^2)))

The Bd Ft Volume equations for an entire untapped tree have been presented above using all 3 log scales. However, in the interest of time and space, I have only presented the Doyle scale equations for the bd ft volumes equations for an entire tapped tree, the butt log of tapped and untapped trees, and above the butt log for tapped and untapped trees. The only aspect that would change for these equations using the Scribner and International scales is the coefficients in the equations, so I did not feel it was necessary to include all of them in this document.

Board Ft Volume of the Entire Tree Tapped; Doyle Scale (BFVETTDS)
=((0.55743*(#16LT ^2))+(41.51275*#16LT)-29.37337)+(((2.78043-(0.04516*(#16LT ^2)) - (8.77272*#16LT))*TTD))+(((0.04177-(0.01578*(#16LT ^2)) +(0.59042*#16LT))*(TTD^2)))

Board Ft Volume of the Butt Log Untapped; Doyle Scale (BFVBLUDS)
=((0.55743*(#16LABT ^2))+(41.51275*#16LABT)-29.37337)+(((2.78043-(0.04516*(#16LABT ^2)) - (8.77272*#16LABT))*UTD))+(((0.04177-(0.01578*(#16LABT ^2)) +(0.59042*#16LABT))*(UTD^2)))

Board Ft Volume of the Butt Log Tapped; Doyle Scale (BFVBLTDS)
=((0.55743*(#16LABT ^2))+(41.51275*#16LABT)-29.37337)+(((2.78043-(0.04516*(#16LABT ^2)) - (8.77272*#16LABT))*TTD))+(((0.04177-(0.01578*(#16LABT ^2)) +(0.59042*#16LABT))*(TTD^2)))

Board Ft Volume above the Butt Log Untapped; Doyle Scale (BFVABLTDS)
= (BFVETUDS) - (BFVBLUDS)

Board Ft Volume above the Butt Log Tapped; Doyle Scale (BFVABLTDS)
= (BFVETTDS) - (BFVBLTDS)

Untapped Stumpage Rate Butt Log (USRBL)
=IF(Sp="red",((VLOOKUP((UTD-(#GRBL *2)),IST, SRURM))+((Current Year-Year 1)* $ΔUSRBL)), ((VLOOKUP((UTD-(#GRBL *2)),IST, SRUSM))+((Current Year-Year 1)* $ΔUSRBL))

Untapped Stumpage Rate Above the Butt Log (USRABL)
=IF(Sp="red",((VLOOKUP((UTD-((#GRUL *2)+2)),IST, SRURM))+((Current Year-Year 1)* $ΔUSRUL)), ((VLOOKUP((UTD-((#GRBL *2)+2)),IST, SRUSM))+((Current Year-Year 1)* $ΔUSRUL))

Untapped Stumpage Payment Butt Log (USPBL)
= BFVBLUDS * (USRBL/1000)

Untapped Stumpage Payment Above the Butt Log (USPABL)
= BFVABLUDS * (USRABL/1000)

Tapped Stumpage Rate Butt Log (TSRBL)
=IF(Sp="red",((VLOOKUP((TTD-(#GRBL *2)),IST, SRTRM))+((Current Year-Year 1)* $ΔTSRBL)), ((VLOOKUP((TTD-(#GRBL *2)),IST, SRTSM))+((Current Year-Year 1)* $ΔTSRBL))

Tapped Stumpage Rate Above the Butt Log (TSRABL)
=IF(Sp="red",((VLOOKUP((TTD-((#GRUL *2)+2)),IST, SRURM))+((Current Year-Year 1)* $ΔTSRUL)), ((VLOOKUP((TTD-((#GRBL *2)+2)),IST, SRUSM))+((Current Year-Year 1)* $ΔTSRUL))

Tapped Stumpage Payment Butt Log (TSPBL)
= BFVBLTDS * (TSRBL/1000)

Tapped Stumpage Payment Above the Butt Log (TSPABL)
= BFVABLTDS * (TSRABL/1000)

Untapped Stumpage Payment Present Value (USPPV)
=(USPBL + USPABL)/((1+DR)^(Current Year-Year 1))

Tapped Stumpage Payment Present Value (TSPPV)
=(TSPBL + TSPABL)/((1+DR)^(Current Year-Year 1))

Annual Lease Payment Spreadsheet Calculation (ALPSC)
=IF(TTD < D2T,(ALP+((Current Year - Year 1)* $ΔALP)),(2*ALP)+(Current Year - Year 1)*(2*$ΔALP)))

Annual Lease Payment Present Value (ALPPV)
=ALPSC/((1+DR)^(Current Year-Year 1))

Cumulative Annual Lease Payment Present Value (CALPPV)
In Year 1
= ALPPV (Year 1) + CALPPV (Year 0)

Regular Taxes per Tree Present Value (RTPTPV)
= - (RTPT/((1+DR)^(Current Year-Year 1)))

Cumulative Regular Taxes per Tree Present Value (CRTPTPV)
In Year 1
= RTPTPV (Year 1) + CRTPTPV (Year 0)

Ag Assessment Taxes per Tree Present Value (AgTPTPV)
= - (AgTPT/((1+DR)^(Current Year-Year 1)))

Cumulative Ag Assessment Taxes per Tree Present Value (CAgTPTPV)
In Year 1
= AgTPTPV (Year 1) + CAgTPTPV (Year 0)

Net Present Value (tapping/cutting vs. delayed harvest)
= (TSPPV + CALPPV + CAgTPTPV) – (USPPV + CRTPTPV)

Net Present Value (tapping/cutting vs. immediate harvest)
= (TSPPV + CALPPV + CAgTPTPV) – (USPPV in Year 1 + RTPTPV in Year 1)

Net Present Value (continuous tapping vs. delayed harvest)
= (CALPPV + CAgTPTPV) – (USPPV + CRTPTPV)

Net Present Value (continuous tapping vs. immediate harvest)
= (CALPPV + CAgTPTPV) – (USPPV in Year 1 + RTPTPV in Year 1)