

Introduction to TIPSY version 3.0



Instructor

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Schedule

Start Time:	8.30 am
Coffee Break:	10:00 am
Lunch:	12:00 pm to 1:00 pm
Coffee Break:	2:30 pm
Wrap-up:	4:30 pm

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G&Y Programs Registration and Download

TIPSYPY (version 3.0), VDYP(version 1.1); Batch (v6.6b) incl. Manuals, SiteTools (version 3.2), Introduction to Growth & Yield CBT can be downloaded from our Software Registration and Download page at <http://www.for.gov.bc.ca/research/software/>

For more information about these models please visit the Growth and Yield Modelling Website at: <http://www.for.gov.bc.ca/research/gymodels/>

Introduction to TIPSYS

The Table Interpolation Program for Stand Yields (**TIPSYS**) is a growth and yield program that provides electronic access to the managed stand yield tables generated by [TASS](#) and [SYLVER](#). TIPSYS retrieves and interpolates yield tables from its database, customizes the information and displays summaries and graphics for a specific site, species and management regime. Yield tables are available for various even-aged coniferous species of commercial importance growing on the coast and in the interior of British Columbia.

Overview

- TIPSYS retrieves and interpolates yield tables from its database, customizes the information and displays summaries and graphics for a specific site, species and management regime.
- Information can be entered and displayed in either metric or imperial units.
- It uses optional [Operational Adjustment Factors](#) (OAFs) (Figure 1) to mimic operational conditions. Two types of OAFs are available in TIPSYS to account for elements that reduce potential yields. OAF 1 accounts for the reduction of physical growing space due to holes created by rock outcrops, swamps and non-commercial tree cover. OAF 2 accounts for pest damage that increases towards maturity.
- It includes an economic analysis module, known as the TIPSYS Economist which performs economic analyses on the silvicultural treatments simulated by TIPSYS.
- It has a multiple species option (Figure 2) oriented to timber supply analysis applications. This option is not recommended for silvicultural applications, since TIPSYS does not simulate the growth of multiple species stands biologically. The only biological assumption considered is the site index conversion adjustment among species
- TIPSYS is not a growth and yield model because its principal purpose is to provide electronic access to the managed stand yield tables generated by [TASS](#) and [SYLVER](#).
- A batch version of TIPSYS is also available for processing a large number of stands for timber supply analyses. Batch TIPSYS is included in the program WOODLOT for calculating even-flow harvest rates for a planning period on woodlot licenses.

TIPSYS v. 3.0 New Features

- Existing Stands Option (Figures 3 and 4)
- Genetic Gain (Figures 5 and 6)
- Fertilization (Figures 7 and 8)
- Commercial Thinning for Douglas-fir and lodgepole pine (Figures 9 and 10)
- Coarse Woody Debris
- Jobs Output (ie. silviculture, harvesting and manufacturing labour)
- BatchTIPSYS for Windows
- VDYP, TSB and custom output tables
- New graph option functionality (eg. save, export, points and bars, curves selection, etc.)
- 32 bit processing

Applications

TIPSYS generates managed stand yield tables, including product recovery data, economic analysis, and supporting graphics for:

- stand level crop planning;
- silvicultural prescriptions (e.g., espacement, pre- and commercial thinning, genetic gain and fertilization);
- forest level planning for long term timber supply projections of managed stands. A multiple species feature aggregates stand types into the timber supply analysis units;
- jobs output (ie. silviculture, harvesting and manufacturing labour);
- repressed stands of lodgepole pine;
- dead trees (i.e., standing or fallen);
- coarse woody debris;
- investigations of tree growth and stand dynamic;
- generating [SDMDs](#) (Stand Density Management Diagrams); and
- educational and teaching purposes.

Support

For additional information visit the TIPSY Website at:

<http://www.for.gov.bc.ca/research/gymodels/TIPSY/>

For technical assistance, please contact:

[Mario Di Lucca](mailto:Mario.dilucca@gems4.gov.bc.ca), Mario.dilucca@gems4.gov.bc.ca, Growth and Yield Applications Specialist, or

For software copies and questions regarding installation, please contact:

[Shelley Grout](mailto:Shelley.grout@gems4.gov.bc.ca), Shelley.grout@gems4.gov.bc.ca, Software Applications Specialist

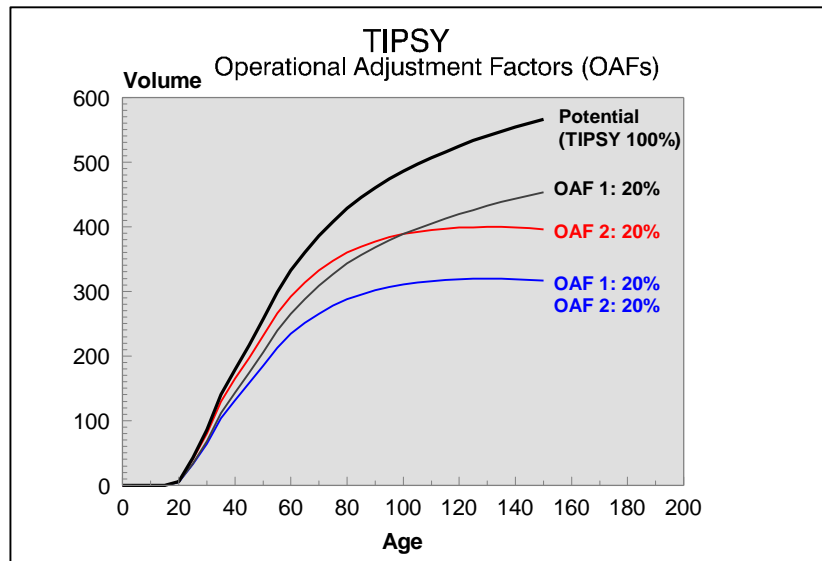


Figure 1. Operational Adjustment Factors (OAFs)

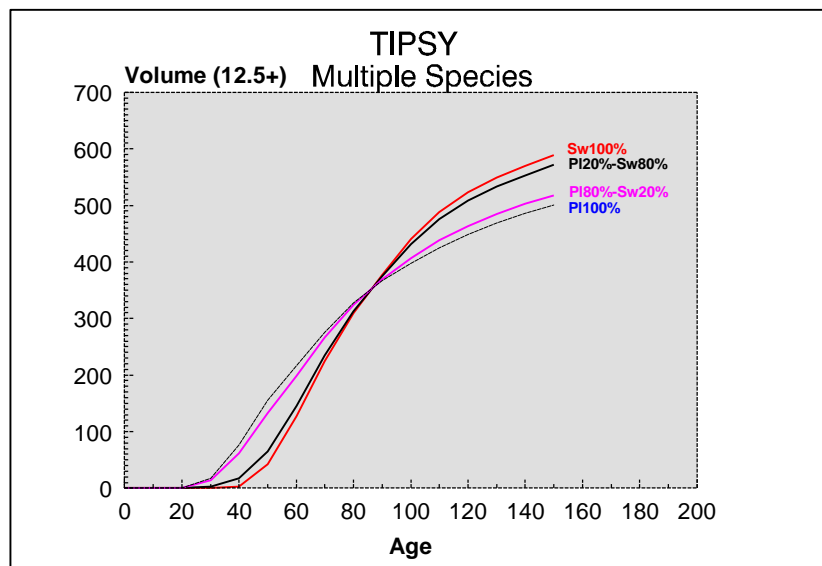


Figure 2. Multiple Species

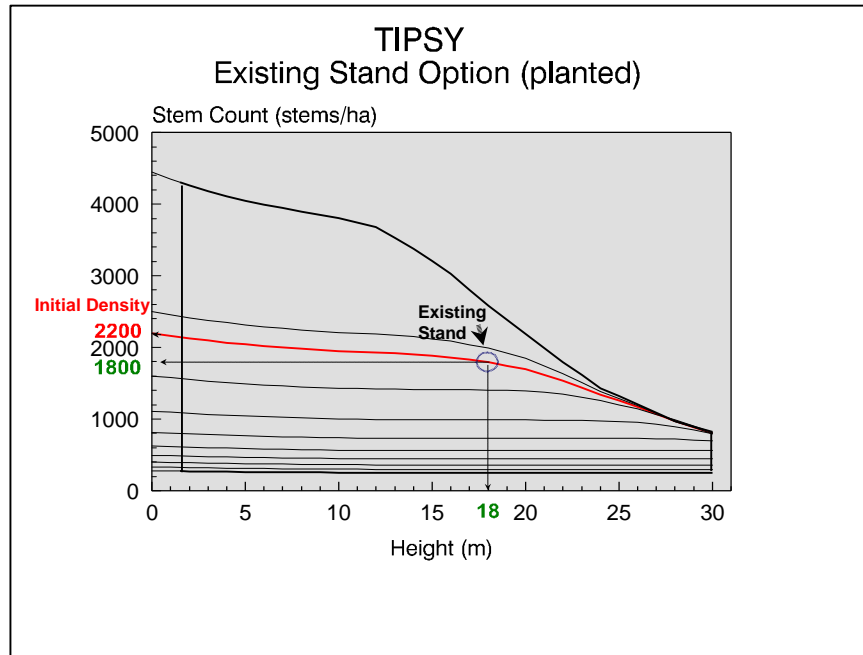


Figure 3. Existing Stand Option (Planted)

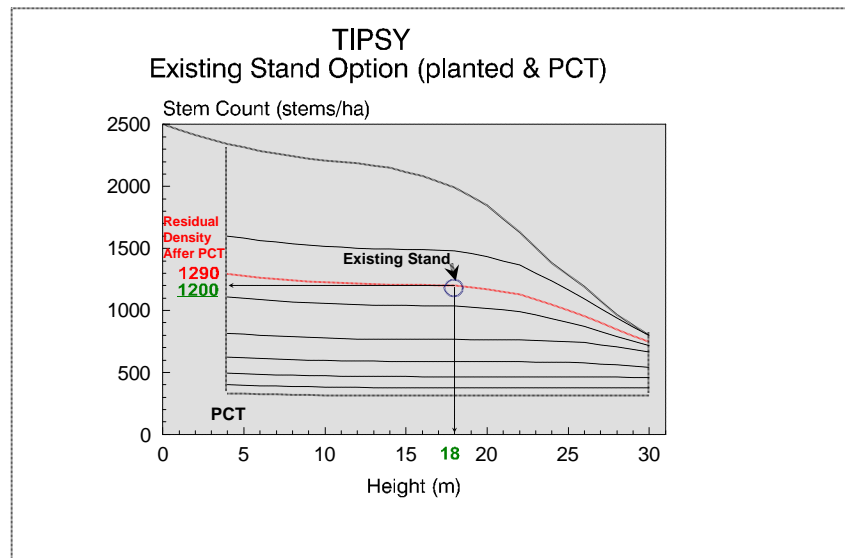


Figure 4. Existing Stand Option (Planted and PCT)

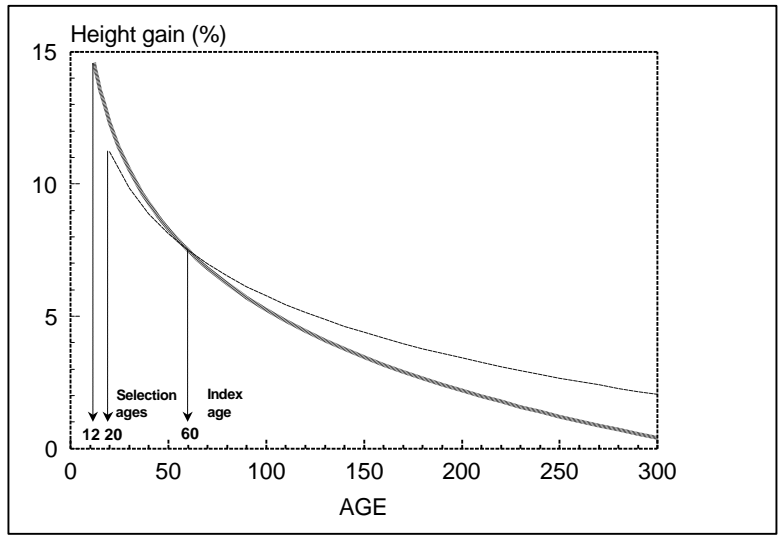


Figure 5. Genetic Height Gain %

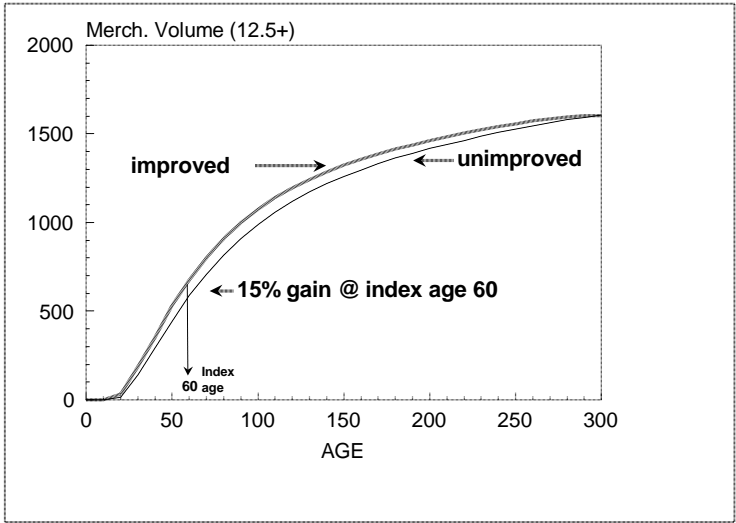


Figure 6. Genetic Volume Gain

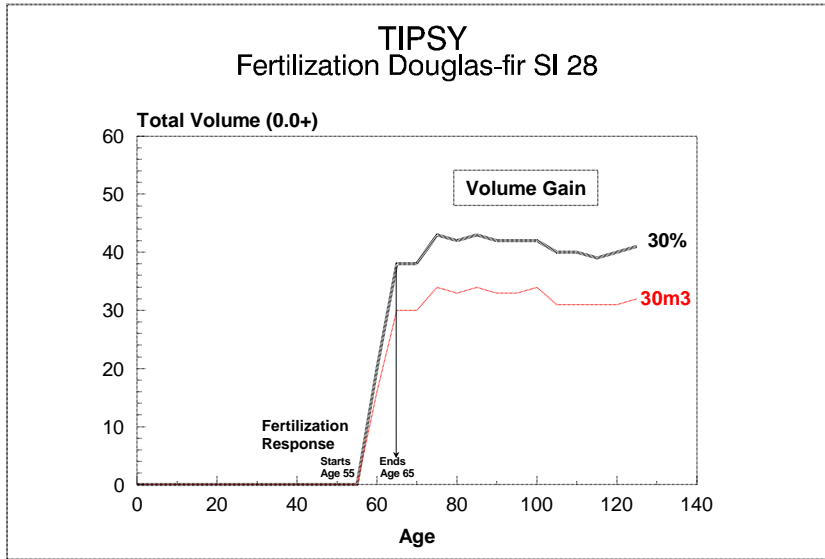


Figure 7. Fertilization Periodic Volume Gain

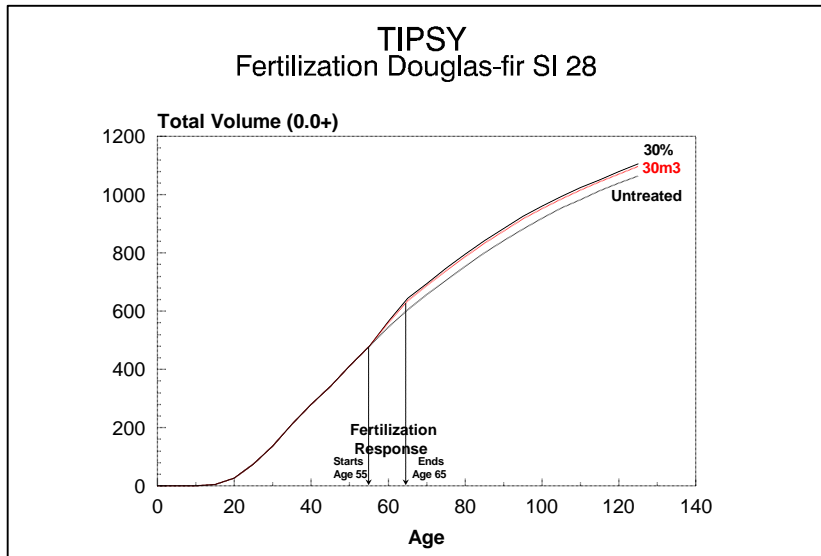


Figure 8. Fertilization Cumulative Volume Gain

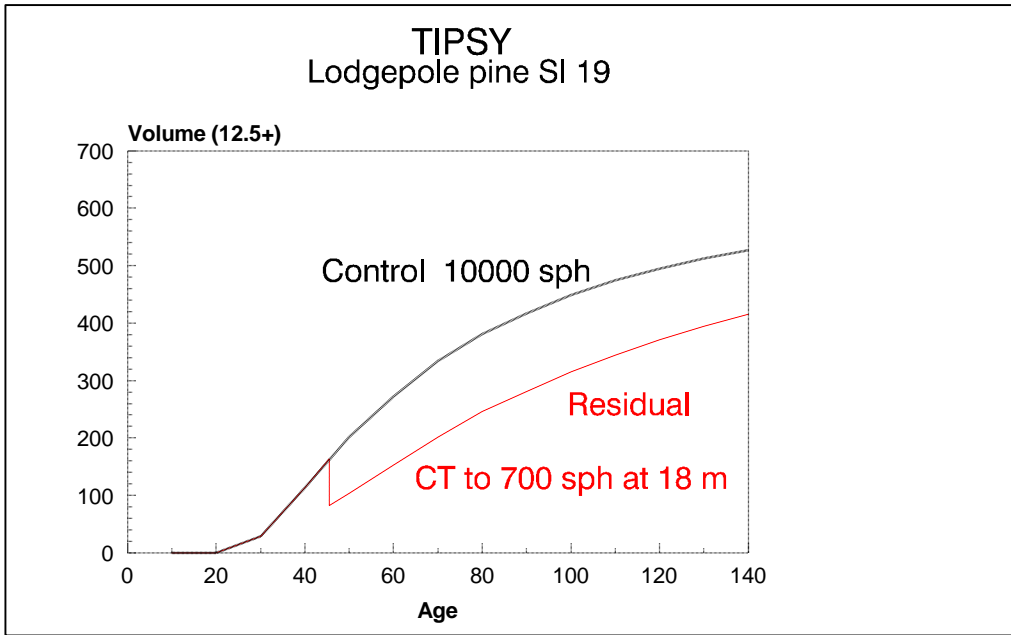


Figure 9. Commercial Thinning

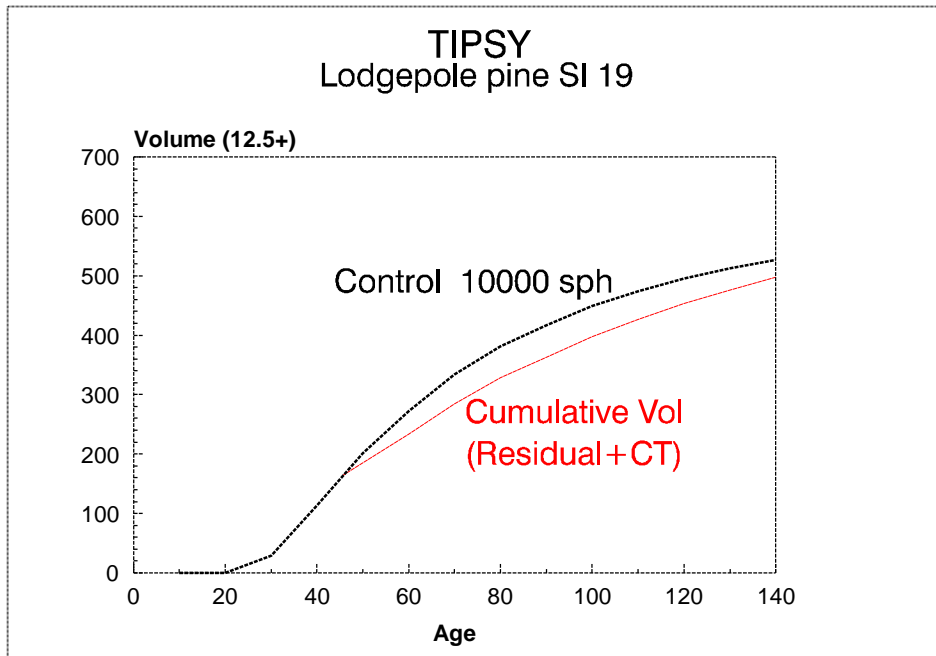


Figure 10. Commercial Thinning (Cumulative Volume)

4. Exploration & Problem Solving Using TIPSY

Section 1: PREPARING TIPSY RUNS AND COMPARING SILVICULTURAL OPTIONS

1. Initial density and utilization limits

How does initial density affect merchantable volume?

When comparing alternative prescriptions it is often helpful to start with graphical comparisons to quickly narrow down the field of reasonable options. Graphing multiple options with TIPSY is a handy skill that is quite easy to learn. The following series of problems will help you exercise that skill.

HINTS: TIPSY allows you to overlay up to 7 curves or graphs and now you can make corrections if you decide to. Read all the questions before you begin setting up your first TIPSY run so you can see what will be needed ahead (e.g., volumes, age ranges, etc.). Perform and save the following runs:

Lodgepole Pine -- SI=20m

Regime #	Initial Density	Stand Origin	SAVE AS ...
1	10000	Natural	10000.tip
2	4400	Natural	4400.tip
3	2500	Planted	2500.tip
4	1100	Planted	1100.tip
5	500	Planted	500.tip
6	300	Planted	300.tip

After completing and saving these runs answer the following questions:

1. Which density reaches 300 m³/ha (**Total Volume 0.0+**) first? _____
2. Does the answer to the first question depend on site index? (yes / no)
3. Which density reaches 300 m³/ha (**Merch. Volume 12.5+**) first? _____
4. Which density reaches 300 m³/ha (**Merch. Volume 32.5+**) first? _____
5. Which density attains the greatest MAI (**Merch . Volume 12.5+**) at culmination? _____
6. If you are willing to accept 90% of this greatest MAI at culmination, what other densities could you accept/consider? _____

7. What then are some management implications if you were managing strictly for greatest MAI at culmination? _____
8. What density reaches 25cm average DBH (DBHg) first? _____
9. What density reaches 25cm average DBH (DBHg) first for the prime 250 trees? _____
10. Between the 1100 and 2500 initial densities, which reaches 25cm average DBH first with a minimum of 300 m³/ha (**Merch. Volume 12.5+**)? _____

2. Existing stand Option

How you might apply the Existing Stand Option for a silvicultural prescription?

Start a new TIPSY file and enter, or check, the following information:

- **Species--Composition-Site:** species (lodgepole pine), genetic worth (0%), composition (100%), site index (19 for the first question) and ministry standard site curves (Nigh 1999);
- **Stand Specifications:** stand regeneration method (natural, planted or clump) and initial density (leave as is). Initial density is unknown but you can estimate it as outlined below after you have updated other items in this dialog box. It is essential that you review the regeneration delay (2), OAF1 (1.0) and OAF2 (1.0) for the existing stand before you determine the initial density and/or the residual density following pre-commercial thinning. All relevant variables can affect the outcome of the Existing
- **Stand Option:** The Existing Stand Option can be used to estimate the initial/establishment density and the residual density following PCT (**Note: fertilization, genetic gain and commercial thinning are not available in this option**).

1. Complete the missing information in the following table:

Know Density	Top Height	Age since				Site Index	Initial Density
		Disturbance (TIPSY age)	Germination (Total age)	Planting	Breast Height		
7500 (Nat.)	6.19			-		19	
1800 (Clump)	15.00			-	24		
1700 (Plant.)	8.05			26			

2. Assume your records show that a natural stand of lodgepole pine growing on site 19 was pre-commercially thinned at TIPSY age 20 from 7500 stems per hectare to an unknown residual density. At TIPSY age 40, the stand supports 1400 trees.

- 2.1 What is the estimated initial/establishment density?

- 2.2 What is the estimated residual density following PCT?

2.3 Now determine the **Merch. Volume 12.5+** and average DBH at age 80 when the stand will be harvested. Use **Merch. Volume 12.5+** and then select Edit and Table to specify a table based on age in steps of 20 from 2 to 82 years. The offset of two years 'excludes' the regeneration

delay. Then look at the **Yield/Max MAI** Table for the corresponding volume and average DBH at total stand age 80.

Merch. Volume (12.5 cm+): _____
 Average DBH: _____

3. Pre- and Commercial thinning and Economic Analysis

How does pre- and commercial thinning affect the final yield and economic return?
 Generate yield, lumber products and economic tables for the following regimes:

Stand Specifications:

- Lodgepole pine stands, naturally regenerated with 10000 sph, with 4 regimes:

Initial Density (sph)	Regime	Save as
10000	none	10000.tip
10000	PCT to 2500 sph	PCT.tip
10000	CT to 700 at 18m	CT.tip
10000	PCT 2500 sph and CT to 700 sph at 18 m height	PCT&CT.tip

- Site index 19
- OAF1&2 =1.00(defaults)
- Regeneration delay as default (2 years)

Table Specifications:

- Select Volumes (Total 0.0+ and Merch 12.5+)
- Output tables using age ranging from 0 to 300 in 10 year steps

Economic Specifications:

- Stand Geography: Kamloops (Region and District), IDF biogeoclimatic zone, slope 10% and distance to support center 100 km
- Economic assumptions: discount rate 4%, real cost and price increase 0%
- Silviculture costs: use default forest district averages
- Tree-to-truck costs: use ground skidding and default forest district averages
- Haul costs: use default interior averages
- Milling cost: use default exponential milling cost
- Miscellaneous costs: use default forest district averages
- Product prices: use default prices for lodgepole pine

Answer the following questions:

1. Create a single graph for the unthinned regime only (10000 sph) overlaying the curves for the variables **Total Volume (0.0+)**, **Merch. Volume (12.5 +)** and **Prime Volume (12.5+)** versus age. Why are the merchantable volumes lower than the corresponding total volumes?

2. Create a single graph overlaying all 4 regimes for **Merch. Volume (12.5 +)** and rank the regimes at age 70 (largest to smallest).

3. Create a single graph overlaying all 4 regimes for **Merch. Volume (12.5 +)** using the cumulative volume (ie. CT removed and Standing volume) displayed in the economic output table and rank the regimes at age 70 (largest to smallest).
-

4. If you want to know the total productivity of your site by looking at the last two graphs, which one would you use?
-

5. Now refer back to your yield, lumber products and economic tables and complete the missing values at harvest age of 70 in the following table:

Regime	Volume				Avg. DBH		Economics		
	Total 0.0+ (m ³ /ha)	Merch. 12.5+ (m ³ /ha)	Prime 12.5+ (m ³ /ha)	Total Lumber (bd ft/ha)	All Trees (cm)	Prime Trees (cm)	Harvest Revenue (\$/ha)	Net Present Value (\$/ha)	Site Value (\$/ha)
10000	378	334	119	72,579	17.8	26.8	34,983	436	466
PCT									
CT	137	93	-	13,826	-	-	-	-	-
Residual	233	217	124	49,998	22.4	27.2	30,431	174	186
PCT& CT Residual			-		-	-	-	-	-

6. Which regime (s) would you select if your management objective is at least to produce 300 m³/ha **Merch. Volume (12.5 +)** by age 70?
-

7. If your management objective is to produce an average diameter of 25 cm by age 70, which diameter would you use? Why?
-

8. How does the **Harvest Revenue** trend across regimes relate to the trend for **Total Lumber Volume**? Surprised?
-

9. Observe the trend in **Site Value** across regimes. Which regime produces the largest **Site Value**? Can you explain why?
-
-

10. What is the main difference between **Site Value** and **Net Present Value**?
-
-
-
-

11. Observe the values enclosed in this table.

Regime	Max MAI		Max Site Value	
	MAI 12.5+cm (m ³ /ha/yr)	Physical Rotation Age (yrs)	Site Value (\$/ha)	Economic Rotation Age (yrs)
10000	4.77	70	466	60
PCT	5.00	70	206	60
CT	4.44	80	186	70
PCT & CT	4.73	70	-13	70

- Compare the range of the MAI values to that of the Site Values. What is your conclusion?

- Compare the range of the Physical Rotation culmination ages to that of the Economic Rotation. What is your conclusion?

4. Genetic Gain, Fertilization, and Economic Analysis

How do genetic gain and fertilization affect final yield and economic return?

Assume that you have to write a stand prescription of a Coastal Douglas-fir stands, planted with 1200 sph growing on a site 30. Use TIPSYS to perform and save the following regimes:

Stand Specifications:

- Coastal Douglas-fir stands, planted with 1200 sph, with the following 4 regimes:

Initial Density (sph)	Regime	Save as
1200	Untreated	Fd1200.tip
1200	Genetic gain 10%	Fd1200G.tip
1200	Fertilization gain 30 m ³ /ha 65 years after planting	Fd1200F.tip
1200	Genetic gain 10% and fertilization gain 30 m ³ /ha 65 years after planting	Fd1200GF.tip

- Site index: 30
- OAF1&2 =1.00(defaults)
- Regeneration delay as default (0 years)
- Genetic gain as default (ie. 10% at index age 60)

- Fertilization gain as default (ie. Absolute volume gain of 30 m³/ha 65 years after planting)

Table Specifications:

- Select Volumes (Total 0.0+ and Merch.12.5+)
- Output tables using age ranging from 0 to 120 in 10 year steps

Economic Specifications:

- Stand Geography: Vancouver, Campbell River, CWH biogeoclimatic zone, slope 10% and distance to support center 100 km
- Economic assumptions: discount rate 4%, real cost and price increase 0%
- Silviculture costs: use default forest district averages
- Tree-to-truck costs: use ground skidding and default forest district averages
- Haul costs: use default coastal averages
- Milling cost: use default exponential milling cost
- Miscellaneous costs: use default forest district averages
- Product prices: use default **Lumber & Chips** prices for coastal Douglas-fir

After Completing these runs answer the following questions:

1. If your management objective is to maximize the mean annual increment for **Merch. Volume (12.5 +)**, which regime would you select?

2. Which regime reaches an average DBH (DBHg) of 40 cm, first?

3. Which regime reaches an average DBH (DBHg) of 40 cm for the 250 prime trees, first?

4. Which regime attains the greatest MAI (**Merch. Volume (12.5 +)**) at culmination?

5. If you are willing to accept 90% of this greatest MAI at culmination, what other treatments would you consider?

6. What then are some management implications if you were managing strictly for greatest MAI at culmination?

7. If your management objective is to maximize the site value, which regime would you select?

5. Operational yields (Operational Adjustment Factors)

How do Operational Adjustment Factors (OAFs) affect yield?

1. Assume that you have 100-year-old forests of **interior Douglas-fir** which originated naturally with 5000 trees/ha, 2 years regen delay on site index 20 following a fire. An aerial survey shows that 15% of the area is comprised of unproductive holes. An intensive ground survey by pathologists reveals that one third of the holes can be attributed to root rot while the remaining holes are the result of rock outcrops, small swamps and uncommercial hardwoods. Run TIPSY in 10 year steps to confirm a potential yield of 411 m³ Merch. Volume (17.5+) at 100 years in the absence of holes and then answer the following questions:
 - i) What is the volume (17.5+) at age 100 in the absence of OAFs?_____
 - ii) What is the volume (17.5+) at age 100 after allowing for OAF 1?_____
 - iii) What is the volume (17.5+) at age 100 after allowing for OAF 1 and 2?____
 - iv) What harvest age will ensure maximum operational productivity (max. MAI 17.5+) in the absence of OAFs?_____

2. Assume all openings are caused by rock outcrops and other OAF 1 factors which account for 35 % of the growing space.
 - i) What is the volume (17.5+) at age 100 after allowing for OAF 1?_____
 - ii) What harvest age will ensure maximum operational productivity (max. MAI 17.5+)?_____
 - iii) Why did the harvest age not change relative to the stand with no OAFs?

3. Next assume that all openings are caused by root rot which accounts for 35% of the growing space.
 - i) What is the volume (17.5+) at age 100 after allowing for root rot (OAF 2)?_____
 - ii) At what age does the volume start to decline? _____
 - iii) What harvest age will ensure maximum operational productivity (max. MAI 17.5+)?_____
 - iv) Why did the harvest age change relative to an OAF 1 of 35% ?

Section 2: INTERPRETING G&Y OUTPUT FOR SILVICULTURAL PRESCRIPTIONS

The single most important pre requisite for interpreting G&Y output (from any model) is stating your management objective(s) in terms you can identify within model output.

E.g. How will I recognise a commercial thinning opportunity within the confines of the model output?

---- OR ----

E.g. TIPSY now gives me average stand diameter, average “prime” or crop tree diameter and diameter distributions. Which one will give me the most complete picture of my “piece size” targets?

The second is a good example of a common trap we often find ourselves in based on our historic targeting habits (setting piece size targets based on average stand diameter) and being unaware of the implications. There are few mensurational statistics as misrepresented (and dangerous) as average stand diameter. Yet it has historically been accepted as the surrogate of choice for piece size, largely because it is so commonly reported, along with other rudimentary stand-level statistics, by simpler (generally older) models. As models evolve they tend to provide a greater breadth of mensurational output that allows us to examine more fully the implications of our targets and prescription decisions. TIPSYS's newly added (and long requested) diameter distributions make it possible to better examine these implications.

By examining diameter distributions you can readily observe the impact of treatments such as pre-commercial thinning (PCT) on average diameter. In particular, you can see how the PCT “chainsaw effect” skews the diameter distribution (and its average diameter) simply due to the removal of small diameter stems. This effect carries through time -- and confounds later interpretations of thinning effect. As a result, the leading edge of the distribution (the larger trees) does not change as dramatically as the average. Focusing on this leading edge results in more meaningful (and less optimistic) interpretations.

1. Average stand diameter as a target rotation

Perform and save the following runs:

Lodgepole pine SI 16, naturally regenerated, with 2 regimes:

Initial Density (sph)	Regime	Save as
10000	control	10000.tip
10000	PCT to 1200 sph	10PCT.tip

After completing and saving these runs answer the following questions:

1. At what age the unthinned run reaches a piece size of 20 cm average DBH (DBHg)? _____
2. At what age the thinned run reaches a piece size of 20 cm average DBH (DBHg)? _____
3. Using the stock tables complete the **Merch. Volume (12.5 +)** missing information:

Regime	AGE	15	20	25	30	35
10000 (control)	60	80	71	20	2	
10000 (control)	70					
10000 (control)	80	70	113	66	18	2
10000 (pct 1200)	60					

4. Plot these data, as a bar graph, for the ages 60, 70 and 80.
 5. What can you conclude from the previous table and the bar graph?
-

6. Does a simple average stand diameter piece size target adequately reflect the PCT dynamics of this stand from the mill's perspective?
-

7. What would be some other (better?) surrogate targets for piece size?
-

ANSWERS TO TIPSY PROBLEM SOLVING

Section 1: Problem 1.

1. 2500
2. No, the order doesn't change, just the magnitude.
3. 2500
4. 500
5. 2500
6. 1100, 2500, 4400, 10000
7. The initial density window is pretty wide. That's comforting as there appears to be room for normal operational variability.
8. 300
9. 300, 500 and 1100 are all very close
10. 1100 (this is easiest to determine from tables rather than graphs)

Section 1: Problem 2.

1. Complete the missing information in the following table:

Know Density	Top Height	Age since				Site Index	Initial Density
		Disturbance (TIPSY age)	Germination (Total age)	Planting	Breast Height		
7500 (Nat.)	6.19	20	18	-	12	19	8811
1800 (Clump)	15.00	30	28	-	24	24	2978
1700 (Plant.)	8.05	26	27	26	21	16	1884

2.1. Estimate the initial/establishment density (Note: This example is included in the TIPSY on-line help).

- a. Select the Density: button
- b. Select the Calculate from Existing Stand button and enter a Known Density (before thinning) of 7500.
- c. Select the BH Age: button, then Years since disturbance (TIPSY Age), and enter Age 20. Note that Top Height is 6.19 m at age 20 on site 19. You can enter top height directly, if known, and have TIPSY calculate the age.
- d. Select OK, check the data entered: 7500 trees at BH Age: 11.9 years and Top Ht: 6.2 m. Enter the Known Density (7500) if it is was not previously within the allowable range.)
- e. Select OK and notice TIPSYs estimate of **8812** trees which regenerated at an average spacing of 1.07 m, and finally select OK to return to the Stand Specifications Dialog box.

2.2. Estimate the residual density following PCT

(This example assumes you have estimated the initial/establishment density.)

- d. In the Stand Specifications dialog box, move to the Treatment group and the PCT box.
- e. Select the button below the PCT box to display the Residual Density dialog box. Since it is unknown, select the Calculate from Existing Stand button, and enter the Known Density (after thinning) of 1400 if it is within the range of allowable post-thinning densities (328 to 4034).

- f. Select the BH Age:.... button, then Years since disturbance (TIPSY Age), and enter the age (40). Note the Top Height of 14.31 m. You could have entered top height instead of age if available from field data. See Notes on Using the Existing Stand Option.
- g. Select OK, check the data entered: 1400 trees at Breast-Height Age 31.9 years and Top Height 14.3 m. (If 1400 trees/ha wasn't previously within the valid range, enter 1400 now in the Known Density (after thinning) box.) Select OK and notice that TIPSY has estimated a post thinning density of **1517** trees with an average inter-tree distance of 2.57 m. Select OK to return to the Stand Specifications dialog box.
- h. To complete the run, ensure that no other treatments have been selected inadvertently and select OK. Review the Stand Description for correctness, and finally, select the icon to view the **Yield/Max MAI Table**.

2.3. In the **Yield/Max MAI Table** look at age 82 (which corresponds to a total stand age 80 plus 2 years of regeneration delay) and the **Merch. Volume (12.5+)** and average DBH are projected to be 405 m³/ha and 23.8 cm, respectively

Section 1: Problem 3.

1. Merchantable volume is lower than total volume because it only considers the total standing volume of trees with diameter greater or equal than 12.5 cm at breast height (inside bark) excluding 30 cm stumps and 10 cm tops. Prime volume is also lower because it only considers the volume from the largest 250 trees per hectare.
2. PCT, 10000, PCT & CT and CT.
3. PCT, 10000, PCT & CT and CT.
4. The second graph provides a better representation of the total site productivity over time.
- 5.

Regime	Volume				Avg. DBH		Economics		
	Total 0.0+ (m ³ /ha)	Merch 12.5+ (m ³ /ha)	Prime 12.5+ (m ³ /ha)	Total Lumber (bd ft/ha)	All Trees (cm)	Prime Trees (cm)	Harvest Revenue (\$/ha)	Net Present Value (\$/ha)	Site Value (\$/ha)
10000	378	334	119	72,579	17.8	26.8	34,983	436	466
PCT	384	350	126	77,658	20.5	28.3	37,143	193	206
CT	137	93	-	13,826	-	-	-	-	-
Residual	233	217	124	49,998	22.4	27.2	30,431	174	186
PCT& CT	111	88	-	14,175	-	-	-	-	-
Residual	259	243	130	55,689	24.2	28.6	33,279	-12	-13

6. The regimes that reach first 300 m³/ha (**Merch. Volume 12.5+**) is the PCT, then 1000, CT and PCT and CT regimes.

7. The **Prime Diameter** (ie. largest 250 sph) will be a better indicator of the stand productivity because it will only include the crop trees of greatest volume and value. This diameter also is less influenced by changes in stand density.

8. **Harvest Revenue** and **Total Lumber Volume** are obviously directly related.
9. The unthinned 10000 sph regime produces the highest site value because it does not consider any PCT nor CT costs.
10. The **Site Value** represents an infinite series of rotations of identical growing regimes and the **Net Present Value represents** a single rotation of one growing regime.
11. - The range for the MAI values varies from 4.44 to 5.00 m³/ha/year. The range for the Site Values varies from 466 to -13 \$/ha. The MAI values are in general less variables than the Site Values.
 - In general the physical rotation age (ie. 70 to 80 yrs) occurs later than the economic rotation age (ie. 60-70 yrs).

Section 1: Problem 4.

1. The combined genetic and fertilization regime.
2. The combined genetic and fertilization regime.
3. The genetic and the combined genetic and fertilization regime reach the target diameter at almost the same time.
4. The combined genetic and fertilization regime.
5. All four regimes will be within the 90% of the greatest MAI.
6. The optimum harvest has a very large opportunity window in all four regimes.
7. The combined genetic and fertilization regime.

Section 1: Problem 5.

1.
 - i) 411 m³ (17.5+)
 - ii) 371 m³ (17.5+)
 - iii) 352 m³ (17.5+)
 - iv) 120 years.

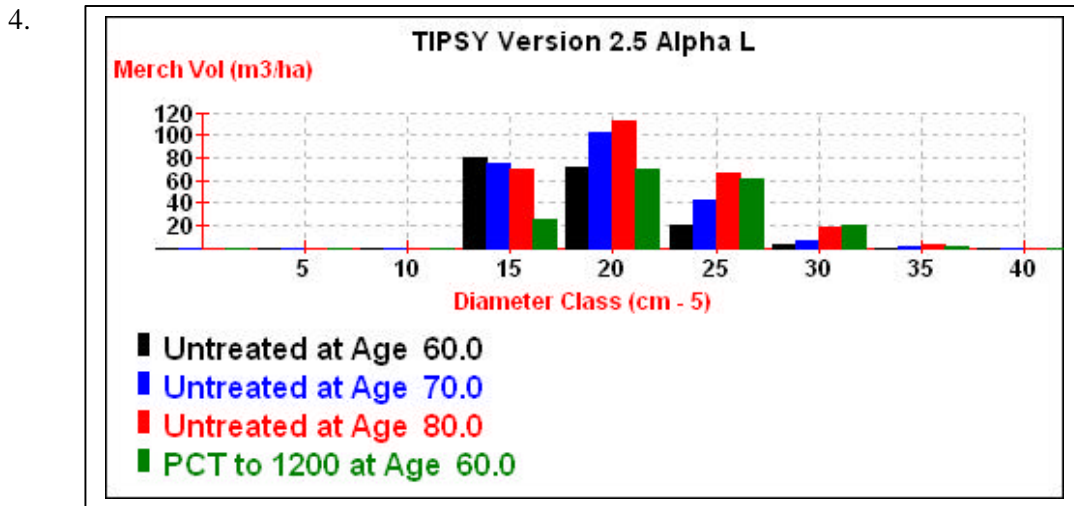
2.
 - i) 267 m³ (17.5+)
 - ii) 120 years
 - iii) Because OAF 1 affects the magnitude of the volume/age relationship but not the shape of the curve.

3.
 - i) 269 m³ (17.5+)
 - ii) 140 years
 - iii) 100 years
 - iv) Because OAF 2 changes the shape of the volume/age relationship by removing an increasingly large proportion of the volume as the stand gets older.

Section 2: Problem 1

1. Age 60
2. Age 120
3. Using the stock tables complete the (**Merch. Volume m³/ha**) missing information:

Regime	AGE	15	20	25	30	35
10000 (control)	60	80	71	20	2	
10000 (control)	70	74	103	42	6	
10000 (control)	80	70	113	66	18	2
10000 (pct 1200)	60	25	70	60	19	2



5. From the previous table and bar graph it can be concluded that the leading edge catches up with the 60 year-old thinned stand at about age 80, with apparently little difference in magnitude. If we are looking at the average stand diameter piece size the difference (ie. “chainsaw effect”) between the untreated and the PCT run is 60 years.
6. The mill manager would rather have the piece size/volume information from a stock table than a simple average stand diameter piece size.
7. The volume distribution by diameter classes (ie. stock table), the average diameter of the largest 250 prime trees, and an economic analysis are better evaluation indicators than the target average stand diameter piece size.