Lesson 4

# Economic Principles of Timber Production

## An Overview

45 minutes

## Lesson Objectives

- To promote a common understanding of economic principles that are pertinent to silviculture investments
- To make participant's aware of the difference between stand level analyses and forest or estate level analyses.

## Method: Introduce the Guidelines – Lecturette

- Go over the main sections outlined in the guidelines
- Provide a summary of Appendix 1 – Predicting Timber Values

## Audio Visual Requirements

- Overhead projector

## Handout

# Spacing – When is it a good investment?

## Key elements

- Objectives – Forest estate level objectives
- Time – Using discount rates and economic analyses
- Revenue/Value – Assumptions and information
- Costs – What to use
- Site Conditions – Growth potential – How to factor it into the analysis.

## Economic Principles

We will go over the terms and methods used to evaluate the question – when is spacing a good investment?

The intent of this section is make you aware of the terms and key elements of an economic analysis.

- Objectives – Forest estate level objectives
- Time – Using discount rates and economic analyses
- Revenue/Value – Assumptions and information
- Costs – What to use
- Site Conditions – Growth potential – How to factor it into the analysis.

Each element will be discussed allowing time for questions and clarification.

# Objectives

## Forest Estate or Stand – Which should I use?

**The guidelines provide direction for stand level economic analyses**

- Forest Estate economic analysis is not covered by the guidelines.

*However...*

- Ideally, stand level analyses are used within Forest Estate Models to determine appropriate treatments – this is the intent for your local planning units.

## Objectives

Forest Estate or Stand – Which should I use?

The guidelines provide a production economics background for evaluating stand density management options.

- Production economics is the process of determining which, among all treatment options capable of meeting forest management objectives, will maximize the return on treatment investment for the forest estate owner.
- This approach is consistent with the philosophy that the purpose of stand density management is to achieve the timber and non-timber production objectives of a forest management plan.

These stand level economics principles are not intended to address social welfare objectives such as income distribution or employment creation.

Therefore to properly assess the economic value of a treatment regime it must be viewed in the context of the Forest Estate.

**Thus the stand level economic analyses described in the guidelines are only an input to the more holistic forest estate level of assessment.**

- It must also be stressed that the models used for Forest Estate planning are run by assumptions and provide imperfect views of reality. All results should be treated with caution and be used as an aid to decision making, not as the decision maker itself.

**The treatment must fit within the Forest Estate strategy or treatments may go against the objectives for the area. Thus it is key to identify forest level objectives and weigh stand density decisions in that light.**

**Examples using present TSR data will be explored later in the session.**

# Economic Principles

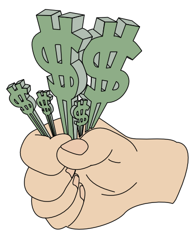
## Stand Level Assessments

Time – how is it accounted for?

Net Present Value vs Site Value

Which one where?

**Treated vs Untreated Net Present Value –**



**Different Regimes Site Value –**

$$SV = \frac{\sum_{i=0}^{A} R_i (1+r)^{A-i} - \sum_{i=0}^{A} C_i (1+r)^{A-i}}{(1+r)^A - 1}$$

$$NPV_u = (R_u - C_u - C_d + Sv_u) / (1+r)^{A-a}$$

$$NPV_t = R_c - C_c - C_d + (R_t - C_t + Sv_u) / (1+r)^{A-a}$$

## Time — How to Account For It

We will go over the concept of density management as an investment, building on the text of the guidelines.

Information about the timing of stand activities is required, since various costs and benefits usually occur during different time periods over the life of a stand.

- Economic analysis converts all costs and benefits to value in today's dollars. This conversion process is referred to as discounting (see *Selecting a discount rate* on page 36). The net present value (NPV) is the sum of all discounted benefits of silvicultural activity or regime, less discounted costs.
- Regeneration costs such as site preparation and planting are incurred within the first few years, whereas density management costs are incurred between stand age 10 and 30.
- Final stand net revenues (revenue less harvest cost) are obtained at the end of the expected rotation period. The procedure for calculating the net present value of a density management treatment in a single stand is straightforward; the net present value of a juvenile spaced stand is compared to that of the same stand without spacing.

In order to make economic comparisons between different stands or different treatments, however, net present value must be calculated over the same time period.

- That is, for each present value, the starting point must be the same for each stand or treatment, and the end point must be the same expected rotation length. Since the timing of different stand treatments and the rotation lengths of different stands are rarely the same, it is often impossible to compare treatments and stands in this manner.
- In these circumstances, **the net present values must be converted to a site value (SV).**

The overhead shows a relatively complex equation that can be used to calculate the Site Value for a stand. In reality you will not likely hand calculate this value, instead it will be done for you in an economic model (for example the TIPSY economist).

A site value is the present value of an infinite number of successive rotations on a site managed under the same regime. An economic comparison of two or more stand management regimes is made possible by calculating and comparing the site value of each, even though they may differ in the timing of stand treatments or expected final harvest.

**This type of analysis helps rank the economic attractiveness of treatment options.**

**For a treatment to be economic (have a higher SV or NPV) using time as a factor, the stand needs to grow value faster than the cost of treatment times the discount rate over the period between treatment and harvest.**

This can be achieved by: obtaining more value at harvest through harvesting efficiencies, higher value products, mill efficiencies (fewer larger logs for the same volume) or greater lumber recovery factor. These conditions must add up to more than the cost of treatment carried over the time until harvest using the discount rate of the day. If the SV is not higher the treatment may still be beneficial at the Forest Estate Level, making it an option (described as a provisional option in the "Structured Decision Process").

# Economic Principles

## Revenue and Value

**This is where we dust of the crystal ball.**

**Three key factors:**

- **Valuation point**
- **Real price changes**
- **Relationship with piece size and price**

## Revenue and Value

Assessing the economics of a proposed silvicultural activity requires information about:

- benefits and costs of the activity from the time of stand establishment to the time of expected harvest
- costs and benefits may be actual, if they have occurred, or expected if they are anticipated in the future.

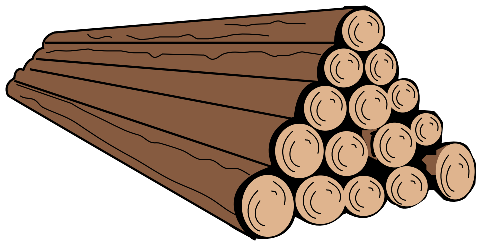
There are no guarantees with economic analyses, or all of our RRSPs would be twice what they are today!

There are some important factors and we will go over them to promote a common dialogue on revenue assumptions.

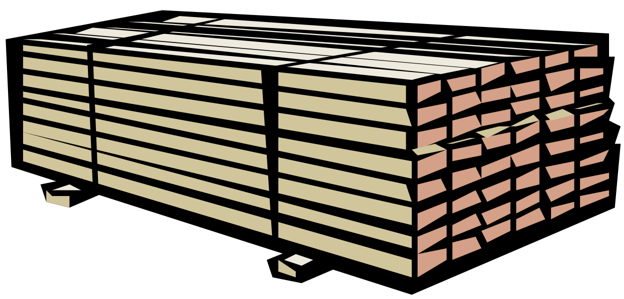
# Economic Principles

## Valuation Point

### Coast



### Interior



## Valuation Point

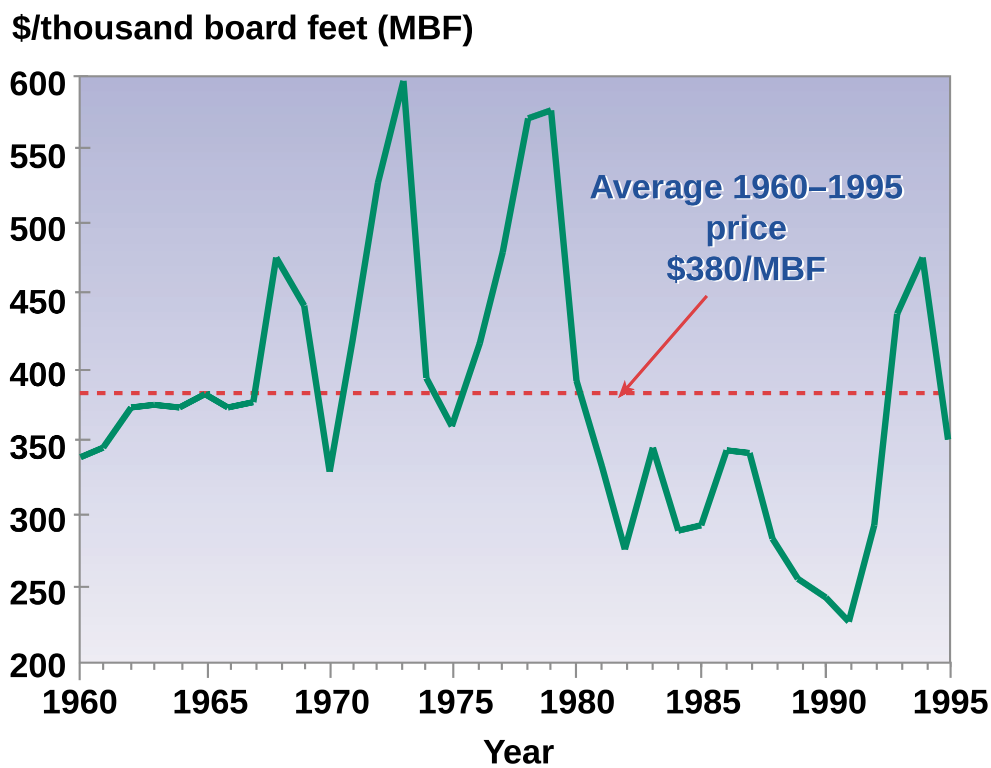
To allow valid comparisons some form of value or worth must be used.

For simplicity, the value of harvested timber can be derived from the selling price of manufactured end-products. A common practice is to evaluate the timber as it moves up manufacturing stages to a point where a market price for a product can be determined. At that point any wood quality differences that affect the product are reflected in the price.

- In the coastal region of British Columbia the end-product values are derived from log transactions on the Vancouver Log Market (Ministry of Forests, 1995b).
- In the interior, where log markets are uncommon, a market value is derived from processed lumber and residual wood chips (Ministry of Forests, 1995a).

# Economic Principles

## Real Price Changes




**No clear trends emerge in real lumber prices in constant 1995 Canadian dollars**

***Supply* and *Demand* are the *Drivers***

**CAUTION IS ADVISED!**

## Real Price Changes

A word of caution – lots of factors are involved.

The graph shown (Figure A1-2 from Appendix 1 of the guidelines) shows trends in real lumber prices in constant 1995 Canadian dollars (western spruce–pine–fir, kiln dried, standard and better, 2×4, random length lumber). It indicates the volatility surrounding price.

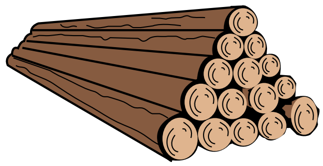
### Conclusions and recommendations

Time in and of itself has no effect on prices, and past prices do not dictate what future prices will be. Market supply and demand forces, which change over time, are what cause prices to change. Use of simple trend models to predict future prices assumes that forces of supply and demand that caused the past price changes are closely correlated with time and that this correlation will continue into the future. This assumption is simplistic, and warrants caution in the use of models based on similar logic.

# Economic Principles

## Long Run Price Increases

### Coast



**Real price increase forecasts for logs from the coastal region**

| Forecast period (years) | Tree species (% price increase/year) | | | |
|---|---|---|---|---|
| | Douglas fir | Cedar | Hemlock | True firs |
| 1990–00 | 1.4 | 3.8 | 0.2 | 0.8 |
| 2000–10 | 0.1 | -0.7 | -0.6 | -0.2 |
| 2010–20 | 0.4 | 0.5 | 0.1 | 0.3 |
| 2020–30 | 0.1 | 0.3 | 0.1 | 0.1 |
| 2030–40 | 0.1 | 0.3 | 0.1 | 0.1 |
| Average | 0.4 | 0.9 | 0.0 | 0.2 |

Source: H.A. Simons Strategic Services Division and Cortex Consultants [1993].

**Caution is the key – note the relatively flat long-term forecast**

**It is recommended to look at other forecasts. Your species mix and product potential may be unique and vary from this estimate.**

## Long-run real log price increases

The table shown is Table A1-1 from Appendix 1 of the guidelines.

The most notable part of the information presented is the lack of long-term price increases from any of the species identified.

However, the footnote states:

*It should be noted that these data are presented only as an example of forecasts typical of the range of values found from a number of recent analyses. They should not be considered the only, or the most accurate forecast of timber prices increases available. See also Feltham and Messmer, 1996.*

Having said that the guidelines recommend:

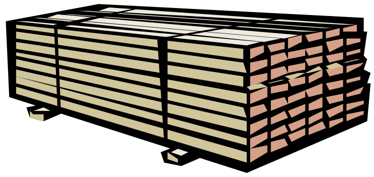
- **Given the factors which mitigate against real price increases**, it is appropriate to **select a conservative estimate of future real price increases.**
- The estimates presented in the table are examples of those typical within the range of most estimates. They are not unreasonable, especially if limited to the 50 year time period shown.

**However, it is recommended to look at other forecasts, your species mix and product potential may be unique and vary from this estimate.**

# Economic Principles

## Long Run Price Increases

### Interior



**Default lumber and wood chip prices used in the TIPSY ECONOMIST (constant 1995 dollars)**

| Species | Lumber ($/MBF) 2×4 | 2×6 | 2×8 | 2×10 | Wood Chips ($/BDU) |
|---|---|---|---|---|---|
| Fdc | 455 | 460 | 455 | 560 | 110 |
| Pl | 380 | 369 | 376 | 452 | 110 |
| Hw | 406 | 406 | 414 | 491 | 110 |
| SS | 380 | 369 | 376 | 452 | 110 |
| Cw | 482 | 482 | 583 | 583 | 15 |
| Sw | 380 | 369 | 376 | 452 | 110 |
| Fdi | 426 | 430 | 439 | 554 | 110 |

Source: Stone *et al*., 1996.

**These values are used in the TIPSY economist and may provide reasonable long-run estimates**

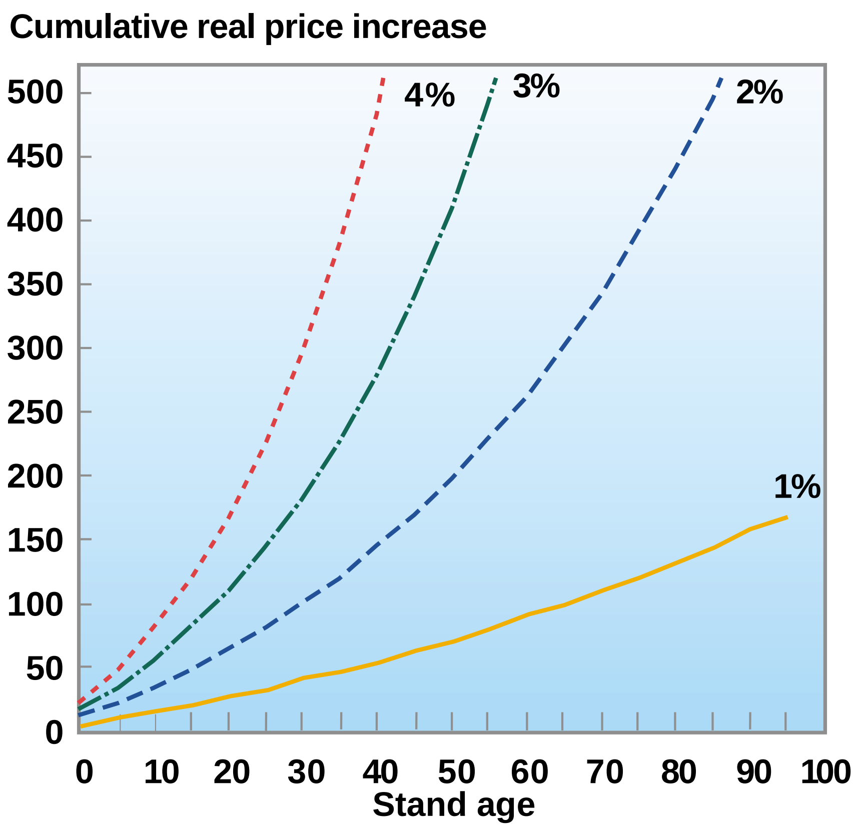
## Long-run real lumber and chip prices

The table shown is Table A1-2 from Appendix 1 of the guidelines.

- The guidelines suggest the real lumber and wood chip prices presented in Table A1-2 may provide reasonable long-run estimates (Stone *et al.*, 1996).
- The long-run real price of 2×4 lumber for each species is the average for the periods studied, while the price for other dimensions is a function of the 2×4 price and the average price ratio of dimension lumber to 2×4 lumber.

# Economic Principles

## Long Run Price Increases



## Real Per Annum Price Increases – A Word of Caution

Given the lack of any clear trend in past real lumber prices (as indicated in Figure A1-2 [OH 4.6]), and the likelihood of only modest real price increases for logs in the future, caution is warranted in making future value assumptions when evaluating the economic efficiency of silvicultural investments.

- For example, the overhead illustrates the cumulative effect of annual real price increases of 1%, 2%, 3%, and 4%.
- If these annual price increases were compounded over a period of 75 years, as they might be in an analysis of juvenile spacing for instance, the resulting cumulative increase in timber value would be 111%, 342%, 818% and 1795%, respectively.

The significance of these extremely high future values is considerable in the calculation of net present value or site value of a stand density management investment analysis.

The compounding effect of an assumed annual price increase can be reduced by limiting the period over which the compounding takes place.

- For example, an assumption of a 1% per annum real price increase over the first 25 years with no real price increase thereafter results in a cumulative real price increase of only 28%.

The figure used is from Appendix 1 (Figure A1-9) of the guidelines.

**This is why you want to invest early in your RRSP! (or is it too late?)**

# Economic Principles

## Harvesting Costs

**How does density management affect costs of the various harvesting phases?**

| | |
|---|---|
| Fixed costs | No change |
| Tree to truck | Less – fewer stems yarding the biggest factor |
| Log haul | Less – fewer stems |

See Stone 1996 articles and the *Appraisal Manual* for help.

## Harvesting costs

Harvesting costs can be categorized by harvesting phase, such as road and site development costs, tree-to-truck costs (felling and yarding), log haul costs (loading, truck haul, towing, or barging), and administration and overhead costs. The effects of density management on each cost phase must be accounted for in any analysis.

Development, overhead and administrative costs are examples of fixed harvesting costs.

- Density management treatments that result in changes to the volume of timber produced by a stand will not affect total fixed harvesting costs, but will affect the average fixed costs per cubic metre of timber produced.

Density management treatments have a larger impact on certain components of tree-to-truck and log haul costs, which are examples of variable costs.

- For instance, log haul costs are influenced primarily by changes in loading time resulting from the number of logs required to complete a load. However, the cost of the loading component of log haul costs is relatively small.
- Density management practices have greatest impact on tree-to-truck costs, particularly the yarding component.

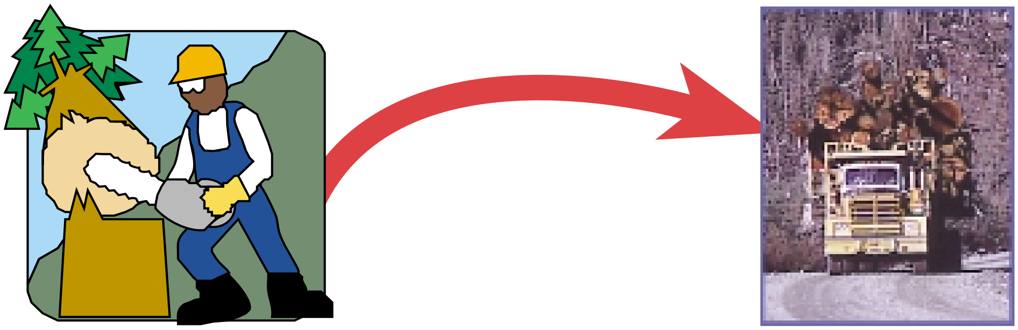
For further information on more detailed aspects of harvesting costs, refer to the Ministry of Forests *Appraisal Manuals* (Ministry of Forests, 1995 (a and b) as well as Stone (1996 a and b).

Harvesting costs can be inserted into the TIPSY economist to approximate local conditions. Appendix 2 in the guidelines provides a sensitivity analysis to indicate where the “break-even” point of treatment occurs by varying harvesting costs.

For example, how much of a difference in tree-to-truck costs is required to equate the returns from the thinned and unthinned stands? Or, at what harvest cost does the net economic gain from thinning equal zero? And, how does it differ from the tree-to-truck costs used for the unthinned stand?

# Economic Principles

## Future Harvest Costs



## Tree-to-Truck – Working With the Numbers

**Use TIPSY economist to 'game' harvest costs – an example is spelled out in Appendix 2 of the guidelines.**

### Example

- **Discount the cost of spacing to year zero ($660 at 17 years = $339 at year zero).**
- **Set thinning costs to zero and reduce tree-to-truck costs until the site value between the two regimes at the economic rotation (age 80) in the example matches the discounted spacing cost ($339 in this case).**

**Tree to truck costs need to be $9.90/m$^3$ compared to $14.36 used by the model.**

**Is this a reasonable cost?**

## Future Harvest Costs

The guidelines provide the following example that you may wish to lead the group through.

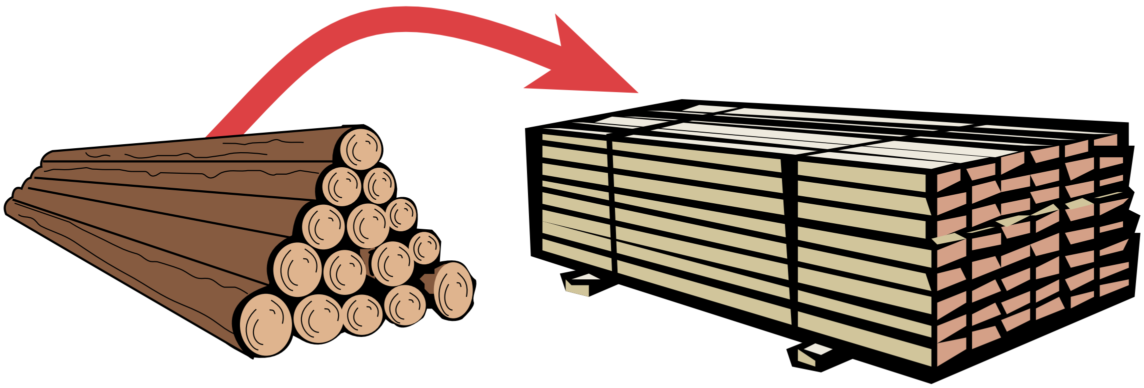
Consider two coastal hemlock stands at an economic rotation age of 80 years. One is unthinned and the other is thinned to 900 trees/ha. Thinning costs are $660 at age 17, which discounts to $339 at age zero. This is the amount by which the site value of the thinned regime must exceed that of the unthinned regime to offset the cost of treatment. The average default tree-to-truck costs in TIPSY are similar ($ 14.36/$m^3$ Vs $ 14.43/$m^3$) for the two regimes.

- ▲ Set the thinning costs to zero as in the preceding example and reduce the tree-to-truck costs of the thinned stand in small increments using the “Constant Cost” option until the difference in site values between the two regimes at age 80 matches the discounted spacing cost of $339.
- ▲ Table A2-8 shows that treatment would have to reduce tree-to-truck costs from $14.36 to $9.90/$m^3$ for a savings of $4.46.
- ▲ That is, it would be justified economically to thin the stand to 900 trees/ha if it reduced the average tree-to-truck costs by 31% relative to the unthinned stand assuming no increase in end product value.

Go over the results of the example and provide some closure.

# Economic Principles

## Milling Costs



## Used for Interior Runs

**For more information see Stone (1996a) and Stone *et al.* 1996.**

### Points to ponder

- Lumber recovery is greater with larger logs
- Logs with a 10 cm top cost 70% more to mill than logs with 40 cm tops
- Stumpage deducts the difference

## Milling costs

The guidelines provide the following information:

**Coast**

- Milling costs need not be accounted for in economic analysis based on log values, since the log prices used in the analysis should already reflect differences in milling costs.
- However, when the analysis is based on lumber and wood chip end products, the effects of density management treatments on milling costs must be accounted for.
- Larger log sizes result in lower milling costs, although other factors, such as log taper, must also be considered. Stone (1996a), and Stone *et al.* (1996) illustrate a method for predicting changes in milling costs.
- Lumber Recover Factor appears to play a significant role in milling costs.

Stone in *An Economic Analysis of Lumber Manufacturing Costs in the Interior of British Columbia* WP-6-014, 1996c provides the following:

By using formula suggested by Stone (1996c) an estimated cost of milling can be created.

Average Total Cost Function $ATC = 2234.31\ LRF^{-0.5199}$

or

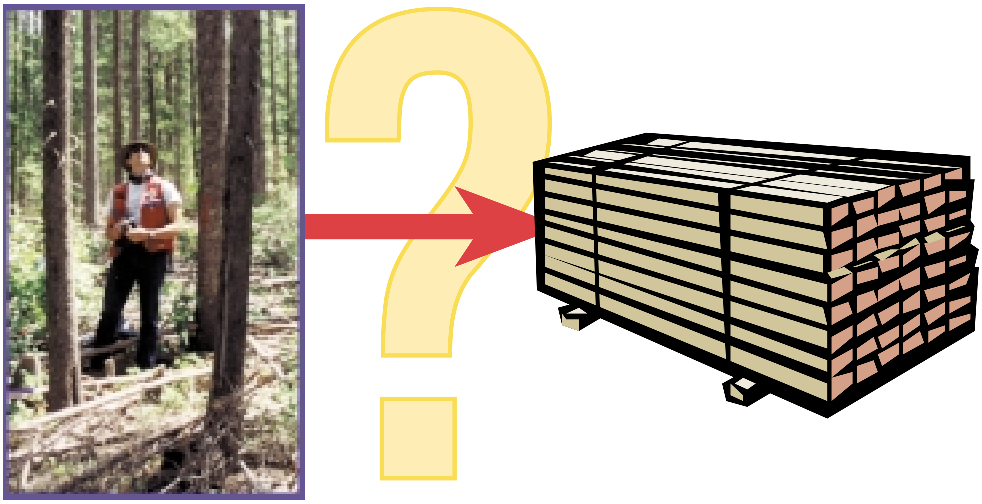
Average Total Cost Function $ATC = 422.66 - 2.0521\ LRF + 0.003418\ LRF^2$

- What this does is provide a cost of milling that relates to the diameter of the input logs.
- Using a top diameter of 10 cm provides a LRF of approximately 150 board feet per cubic metre.
- A log with a top diameter of 40 cm has a LRF of about 230 board feet per cubic metre.
- These relate to $220/MBF milling cost to about $130/MBF or about 70% increase in milling costs for the small dimension lumber.

**NOTE –** The interior stumpage appraisal system derives the value of standing timber by deducting all harvesting, transportation, and manufacturing costs from the value of lumber and chips from the stand. Therefore higher milling costs for small dimension wood result in reduced stumpage payments for the stand.

# Economic Principles

## Silviculture Treatment Costs



### Treatments

**Cost will affect your economic analysis**

- ▲ Cheaper treatments will look more attractive
- ▲ Local market will dictate – use local numbers when available
- ▲ Later treatments are more attractive than early ones
- ▲ Treat when biologically optimal

## Silviculture Treatment Costs

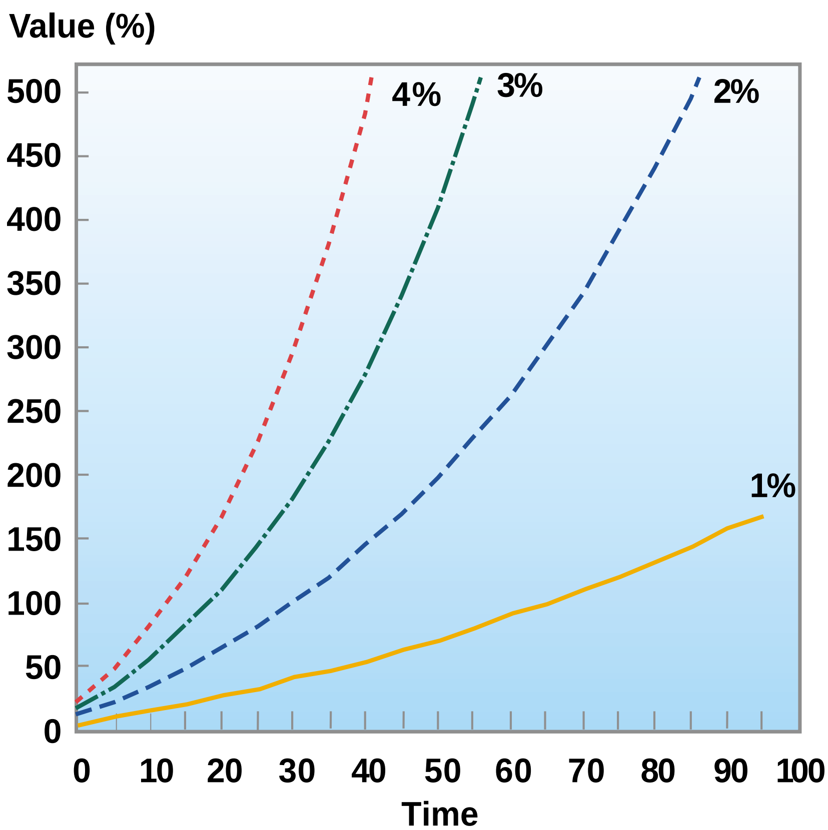
The guidelines provide the following information:

The cost of stand density treatments is usually a function of site and stand conditions such as:

- road access and travel distance,
- the average slope of the site,
- original stand density,
- the number of trees removed, and
- the average height and diameter of the trees removed.
- Local labour market conditions may also influence treatment prices.
  - For instance, the number of silviculture operators available to bid on a project and the amount of work currently under contract may have a substantial effect on treatment prices.
  - **Local market treatment costs should be used to assess density management options. If this information is unavailable, regional average costs may be used.**

# Economic Principles

## Selecting a Discount Rate




# What about 4%?

## Government used real rate – inflation factored out.

## Selecting a Discount Rate

The guidelines provide the following information:

Silvicultural investments are characterized by treatment costs and benefits which occur in different time periods through the rotation. These costs and benefits must be converted to present values in order to assess investment efficiency.

- ▲ The purpose of a discount rate in an economic analysis is to reflect the preference that societies, organizations, or individuals have for present, versus future consumption.
- ▲ **Income received, or costs incurred today are considered to be worth more than income or costs which occur in some future time period.**
- ▲ The rate of discount is used to determine how much less future revenues or expenditures represent in today's dollars. Discounting permits a comparison of various flows of benefits and costs occurring over time in a consistent and logical manner.

Choice of a discount rate is influenced by markets for capital, opportunity costs of capital, risk, and perceptions of risk, uncertainty, inflation expectations, differences in the rate of borrowing and lending, as well as other factors.

- ▲ Governments and private sectors are both influenced by these factors, however private sectors of the economy are affected to a greater degree due to uncertainties in future product demand, natural resource conservation policies, and the wider range of alternative investment opportunities available.

Heaps and Pratt (1989), in *The Social Discount Rate for Silvicultural Investments*, estimated the discount rate using the social opportunity cost of capital for public sector investments in Canada, and found a range of between 3 and 7%, depending on how risk and uncertainty are accounted for. They argued that a risk-free rate should be used for silviculture investments, and recommended a discount rate of between 3 and 5%.

**The Ministry of Forests uses a 4% real rate of discount for public sector forestry investment analysis. The discount rate, whether public or private, is a "real" discount rate. This means that it does not include any inflationary expectations. Inflation is "netted out" of a real discount rate since it is assumed to affect both costs and prices equally over time.**

Whatever discount rate is selected, it must be used consistently for all silvicultural treatments. For example, although a lower discount rate would "improve" the economics of juvenile spacing, it would also reduce the benefits derived from commercial thinning. The discount rate is clearly a two-edged sword.

# Economic Principles

## Sensitivity Analysis

# An Important Step

**This can be used to "game" future values and costs as well as assessing "how robust" the analysis is.**

## The importance of sensitivity analysis

Sensitivity analysis is an important analytical method used to evaluate the effects of risk and uncertainty in economic analyses.

- Sensitivity analysis involves re-calculating the site value of a silvicultural treatment using a range of values around key factor assumptions.
- Key factors in an economic analysis include, future revenue, harvest cost, milling costs, silviculture costs (regeneration, tending, protection, administration) and investment period (rotation length).

For example, a sensitivity analysis of future harvesting cost would involve repeating the economic analysis using harvesting costs that are slightly higher and slightly lower than the expected value.

- The usual approach is to test values within plus and minus an arbitrary percentage (e.g., 10%) of the expected value.
- The sensitivity analysis is performed while keeping all other key factors constant.

The three site values from the sensitivity analysis (base case, -10% and +10%) are then compared; large differences indicate that site value is "sensitive" to small changes in harvesting cost.

Sensitivity in one or more key factors suggests that the economic analysis is not robust, and may lead to errors of interpretation. The outcome of the sensitivity analysis will determine whether all input values and assumptions should be re-evaluated.

### An example from Appendix 2

The example analyses were based on the assumption that real end-product prices remain constant over time (i.e., wood products will not change relative to the cost of production). Under this assumption, juvenile spacing show no net gain in value over no treatment. This leads to the question,

- "How much of an increase in end-product price is required to cover spacing costs?"
- Assume the landowner expects that real end-product prices will rise steadily for the next 25 years and remain constant thereafter.
- What rate of increase is necessary to make the thinned stand as financially attractive as the untreated stand assuming all other costs and values remain constant?

To calculate this “break-even” price increase, discount the cost of thinning ($598) from age 16 to zero at 4%. This amounts to $319, which is the net gain in site value at age zero needed to cover treatment costs.

Set the cost of thinning to zero, and then elevate the “Real Price Increase” in small steps for both stands until the site value of the thinned stand exceeds that of the untreated stand by $319 at age 60. An increase of just over 2.6% is needed to cover spacing costs. Note that a 90% total increase in price results from the 2.6% price increase over 25 years. **This type of analysis can be used as a “reality check.”**

Remember – site growth potential has a major influence on economic analyses as tree growth is geometric as is compounding interest. Good sites can keep up with discounted costs.

**The most important assumptions affecting the economic analysis are:**

- **discount rate**
- **real price increase**
- **site index (growth potential)**