

THE TIMBER GAME

Eduardo de Luna-Solis

Devin McCullough

Dallas Brozik
Marshall University
brozik@marshall.edu

ABSTRACT

The Timber Game is a simulation for teaching sustainability concepts in the context of the Tragedy of the Commons. It presents players with what appears to be a competitive situation but which in reality is a “prisoner’s dilemma”. Players who analyze the situation in advance and recognize the conditions that characterize the tragedy of the commons, common ownership of depletable resources, will adjust their game activities to sustainable levels and maximize their long-run performance. Players who fail to recognize the problem will act competitively, undermining the industry and all other players, resulting in depressed long-run industry and organizational performance.

Keywords: Sustainability, competition, prisoners dilemma, cooperation, resource depletion

SHORT OVERVIEW

The Timber Game is designed as an online game to be played by participants through the aid of computing devices connected to the internet. The participants will be organized into 2-10 teams, of 2-5 players, and play approximately 10-12 rounds (five years per round).

TIMBER GAME PLAYER’S MANUAL

Congratulations. Your leadership team has been selected to operate a company in the timber industry. The Objective of the game is to operate your company and maximum long-term profit generating potential consistent with the constraints of industry as described in the game. The rules and information required for success are provided below.

CRITERION OF SUCCESS

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GAME PLAY

You begin the game with four teams of loggers and four lumber mills that process the lumber. Each team of loggers cuts sufficient timber to keep a lumber mill operating at capaci-

ty. You may increase the size of your company by purchasing additional capacity in balanced pairs of loggers and mills. You may expand capacity by making investment in new operating capacity or you may purchase existing capacity from rival companies. Your company operates in the timber industry in competition against rival timber companies. While there are a significant number of independent timber companies operating in the area, competition has been relatively low during the past two decades.

You operate using five year plans. Your teams of loggers and accompanying lumber mill can harvest and process one parcel of forest in five years. Once you commit resources to a parcel, you will have unrestricted access to that parcel for the five year period, but may not move to another parcel until the five year plan has expired. Your company harvests timber under a long-term federal license on public lands in the Sierra Forest. The federal government regulates timber harvests in the Sierra Forest. The government typically permits harvests on about 100 forest parcels with each parcel containing 10,000 hectares (ha). A hectare is a measure of land area that is about two and half acres.

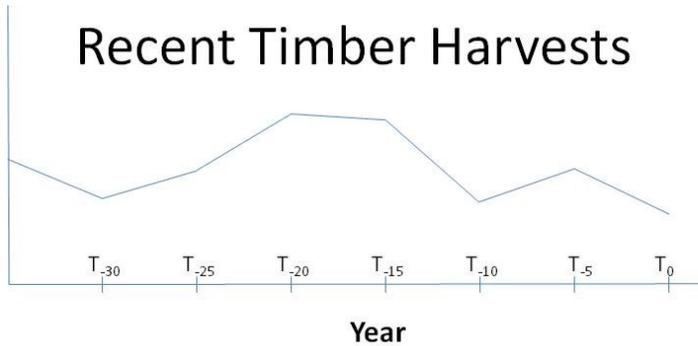
TIMBER AS A CROP

Timber, or wood, is the primary product resulting from the harvesting of trees. Except for the fact that trees take many

The Sierra Forest: Parcels Identified by Row and Column

		Columns											
Parcel 1a		a	b	c	d	e	f	g	h	i	j	k	l
	1												
	2												
	3												
	4												
	5												
Rows	6												
	7												
	8												
	9												
	10												
	11												
	12												

Recent Timber Harvests



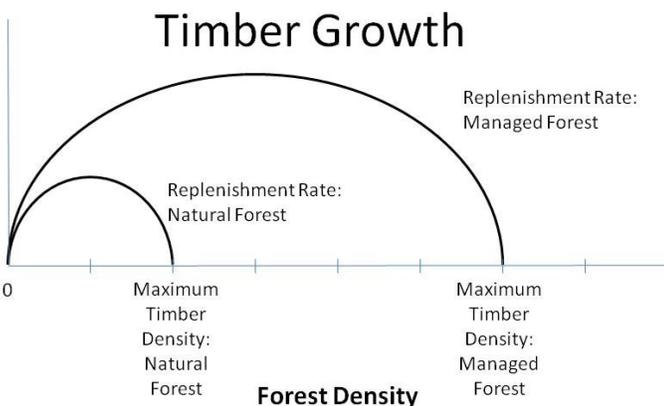
years to reach maturity and the time horizons are correspondingly longer, the logic associated with farming can be applied to trees. Timber farming is a relatively recent human activity. For thousands of years, people could harvest wood from forests without considering sustainability. When human populations are small, forests grow faster than humans consume wood. When human populations reach the levels we have seen since the 1700's, consumption can exceed the wild growth rate and sustainability considerations become more and more important.

BACKGROUND ON THE MARKET FOR WOOD

Wood is composed of the porous and fibrous connective tissue that makes up the bulk of trees (Wikipedia, 2015). Wood is used in many commercial products because of its favorable strength, flexibility, weight, and cost. Pound for pound wood is stronger than steel, yet is flexible and has desirable insulative and aesthetic properties. Wood has been used for thousands of years in the production of dwellings and other structures, furniture, weapons, tools, musical instruments, paper, art, and fuel (AppalachianWood.org, 2015).

Trees grow over the entire course of their lives, reaching commercial maturity in as little as 20 years for some softwood species. Commercial tree production varies depending on many factors including the species. The cost of wood varies greatly with species such as Macassar Ebony costing as much as \$70.00 per board foot and Aspen costing \$2.60 per board foot (BellForestProduct.com, 2015).

The natural carrying capacity of a forest is limited because trees need plenty of space to grow and because trees and other vegetation compete for sunlight. Taller trees with better access to sunlight, grow faster than smaller trees that live in the shade of the taller trees. Competing species crowd out more desirable trees. Dead and fallen trees decompose slowly eventually releasing the nutrients they collected during their lifetimes. For the timber industry, it is ideal to harvest many trees with similar height and girth at one time. This can be achieved if all the



trees in an area are of similar age and the forest has been cultivated for optimal tree production.

The natural carrying capacity of any forest can be enhanced through cultivation that includes: replanting, thinning trees for optimal spacing, removal of competing species, and soil management. Cultivation techniques can multiply the forest's natural carrying capacity by a factor of three. While forest management is desirable from the standpoint of farming, there is risk of planting a single species in one area. When trees of the same species grow too closely, disease may spread rapidly, infecting an entire forest.

RUNNING YOUR BUSINESS – THREE STRATEGIC DECISIONS: CAPACITY CHANGES, HARVEST PLAN, HARVEST LOCATION, & LAND MANAGEMENT

The timber harvest depends on the strategy employed by your company. This strategy involves determining capacity changes, harvesting plan, harvesting location, and land management.

Capacity Changes: The more capacity you have the more you can harvest.

New Lumber Mills You need to determine how many, if any, new lumber mills you intend to purchase each period. Lumber mills must be purchased one year in advance to provide time for equipment ordering and setup, and personnel hiring and training. Lumber mills that are purchased from other companies are already set up and are immediately available.

Purchase Lumber Mills from Other Companies Provided you can reach a mutually agreeable arrangement between companies, one company may sell its lumber mills to another company. This will require each company to notify the game of the number of mills traded and the purchase price for those mills. Lumber mills purchased from other companies are immediately available.

Harvesting Plan:

Your company must decide how much you intend to harvest from the forest. Your harvest plan must be consistent across your entire company and describes the percentage of timber you intend to remove. A harvest plan of 10% indicates you intend to remove 10% of all trees in an area leaving the remaining 90% to be harvested in the future. A harvest plan of 100% indicates that you intend to clear cut all vegetation from an area. Because of the danger of erosion, it is recommended that your harvest plan not exceed 80% of the trees be removed from any parcel. The remaining trees will anchor the topsoil and prevent erosion.

For the most part, the longer you leave trees to grow the larger the harvest. At the extremes this is not entirely accurate. Until trees reach about 20 years old, they typically have little economic value. Harvesting immature trees is likely to result in low yields and have expenses that exceed revenues. As tree parcels approach 50 years, they tend to approach the carrying capacity of the land and the rate of growth in economic value decreases to zero.

Harvest Location

All forest land in the game is public land and available to any company that wishes to harvest on it. The only restriction is that once selected for harvest, it will be unavailable to other companies during that period. The yield per parcels will be influenced by the amount of available lumber on each parcel and a company's harvest plan. For this reason, a company should select parcels that have the greatest amount of timber. Parcels that have been left untouched for long periods of time are likely to have regrown more timber than parcels that have

been recently harvested.

Selection of forest parcels: The selection of parcels is made on the game map. You will select the location to be harvested on the game's interactive map. The map provides information related to the commercial viability of the parcel. Each company may select up to as many forest parcels as it owns. Timber mills. Each mill can be assigned a parcel or can be left idle. The preselected harvest plan will be implemented at each mill-parcels combination.

Land Management

A last set of decisions involves the cultivation activities you intend to perform. These activities are replanting and soil cultivation.

Replanting: Each company has choices about how to manage the land following a timber harvest. Natural reproduction occurs when the existing trees are allowed to reproduce without human intervention. Natural reproduction relies on the wind to distribute seeds. The distribution of trees is random and is limited by the natural carrying capacity of the land.

Reseeding occurs when lumberjacks replant following a harvest using seeds. Reseeding is a cost-efficient way to ensure faster regrowth and more efficient utilization of the next generation forest. Reseeding boosts the carrying capacity of the land because the seeds can be spaced far more densely than natural reproduction but has significant costs. Reseeding costs \$800 per parcel and boosts productivity by 25%.

Replanting with seedlings occurs when lumberjacks replant following a harvest with already growing seedlings. Seedlings are more viable than seeds and can be spaced more optimally than either natural replanting or reseeded. The cost of replanting with seedlings is higher than reseeded. Replanting with seedlings costs \$2000 per parcel and boosts productivity by 50%. The combined effect of replanting and cultivation is multiplicative.

Cultivation: Follow-up cultivation of each parcel of forest optimizes the productivity of the land by thinning the forest to remove forest debris, remove competing species, remove diseased trees, and to ensure the optimal tree density. The duration of cultivation lasts until the next harvest or about 10 periods after which the land returns to a natural state. No cultivation is the lowest cost option and costs nothing.

Moderate cultivation removes trees that are spaced too closely for maximum growth. It removes undesirable species of trees and other competitors to ensure maximum growth rates. Moderate cultivation costs \$8,000 per parcel and boosts land productivity by 50%.

Intense cultivation provides more frequent care to parcels following a timber harvest. Intense cultivation costs \$20,000 per parcel and boosts land productivity by 100%. The combined effect of replanting and cultivation is multiplicative. Replanting from seedlings combined with intense cultivation can result in carrying capacities that are 300% greater than the natural carrying capacity of virgin forest. This translates into much larger harvests and timber revenues.

FINANCIAL DETAILS

The game automatically keeps track of revenues and expenses based on your decisions in the game. The duration of each game period is 5 years. All calculations will be reported on a per-period basis.

Timber Revenue

Since your company focuses on the sale of timber and related forest service products, the total revenue for your company is

your total harvest in kilograms multiplied by the cost of timber per kilogram, \$0.30.

Interest Income

If you have a positive bank balance at the end of a period, the bank will pay you interest equal to 10% of your positive bank balance.

New Lumber Mills Purchases

Each new mill costs \$250,000 and has the capacity to process one forest parcel. Each parcel contains 100 hectares of forest, and is roughly one square kilometer. Each mill includes the operating personnel to both harvest lumber (lumberjacks) and run the mill.

Lumber Mill Operating Expenses

Lumber mills cost \$100,000/period to operate at full capacity. If left idle during a period, lumber mills require an investment of \$40,000 for routine and preventative maintenance.

Transaction Expenses Between Companies

If one team in the game desires to purchase a lumber mill from another team, the transaction will be recorded as sales revenue by the selling team and sales expense by the purchasing team. The mill and its productive capacity will be transferred at the time of sale and will be ready for immediate use by the purchasing team.

Interest Expense

If you have a negative bank balance, the bank will charge you interest equal to 15% of your balance. In practice, you may consider these loans. There is no restriction on the loan amount.

Total Revenue and Expenses per period

The total revenue is the sum of your timber revenue, revenue from the sale of a lumber mill, and interest income. The total expenses are the sum of new lumber mill purchases, lumber mill operating expenses, expenses from the purchase of a lumber mill, and interest expenses.

Cumulative Bank Balance and Annual Profit

Your profits are equal to your Revenues minus your Expenses. At the end of each period your Cumulative Bank Balance and Annual Profit will be compared with the other companies in the game.

STEPS OF PLAY IN EACH PERIOD

1. Determine how much processing capacity (lumber mills) you will purchase this year. New lumber mills will be ready to use in the period after purchase.
2. Buy or sell processing capacity (mills) with other companies.
3. Develop your strategic plan for a) Harvesting Efficiency, b) Replanting, and c) Cultivation.
4. Choose the forest parcels you intend to harvest (1 parcel per lumber mill).
5. The computer program will reconcile annual revenues and expenses to determine each team's end of period bank balance.

ORDER OF TRANSACTIONS

For computational purposes, financial transactions will be as follows:

1. Start the year with your bank balance carried from the previous period.

2. Calculate the cost of new processing capacity.
3. Calculate equipment sales between companies.
4. Calculate the timber harvest
5. Calculate operating costs
6. Calculate revenue from timber sales.
7. Calculate interest revenue or expenses based on end of year bank balance.
8. Calculate end of year bank balance.

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