The Land Expectation Value and the Forest Value

Lecture 6 (4/20/2016)

The value of forest land

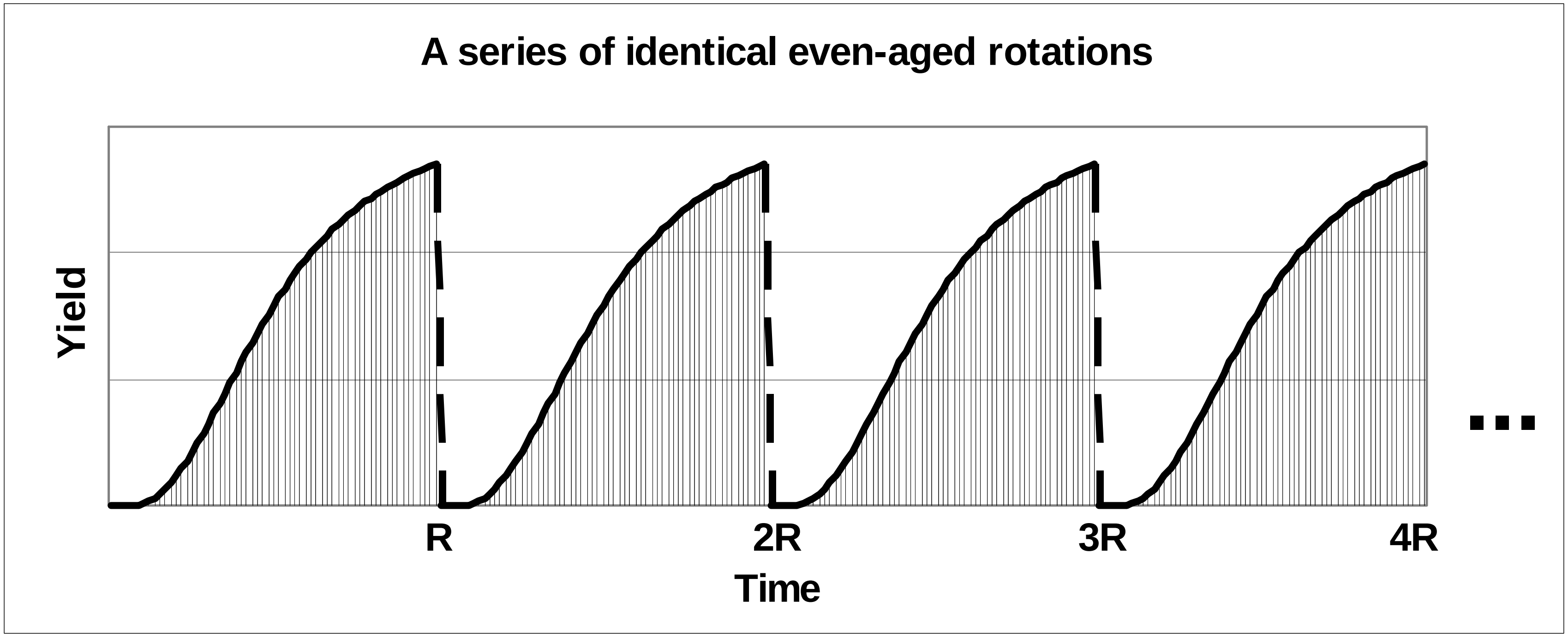
- The Land Expectation Value:* considers the value of bare land at the start of an even-aged forest rotation;
- The Forest Value: considers the value of land and trees at any stage of stand development;
- Transaction Evidence Approach: is based on identifying recent sales with similar properties.

*Note: LEV is also known as the Soil Expectation Value, Willingness to Pay for Land or Bare Land Value

Definition of LEV

<u>The Land Expectation Value (LEV)</u> is the net present value of an infinite series of identical, even-aged forest rotations, starting from bare land.

<u>Major Assumption of LEV:</u> the rotations are identical



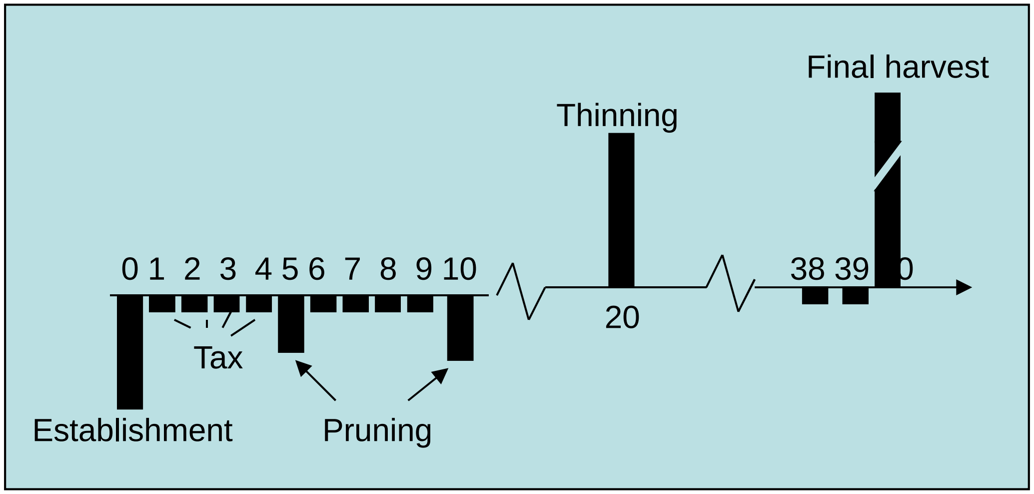
The LEV can be used:

- To identify optimal even-aged management regimes for forest stands where the primary objective is to maximize financial returns;
- To estimate the value of forestland without standing timber that is used for growing timber.

Limitations of LEV

- LEV is a poor predictor of forestland value if the main value of land is not timber related;
- LEV can be used to estimate the opportunity costs of various management regimes;
- Prices and costs are assumed to be constant (use real rate).

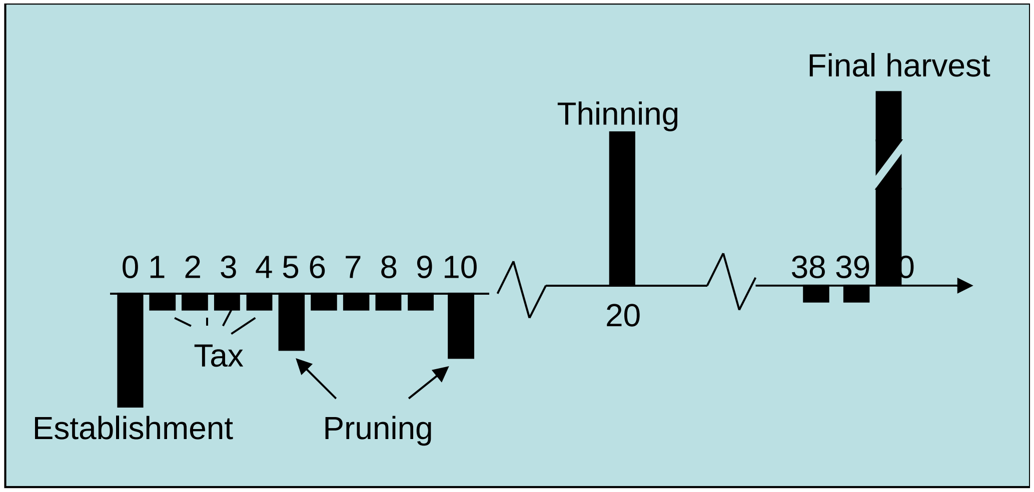
Calculation of LEV



<u>Basic types of costs & revenues:</u>

1. Establishment costs (e.g., site prep., planting)
2. Annual costs and revenues (e.g., property tax, hunting leases)
3. Intermediate costs and revenues (thinnings, pruning, etc.)
4. Final net revenue

Calculation of LEV



- <u>Method 1:</u>

1. Calculate the present value of the first rotation;

$$PV_{R_1} = -E + \sum_{t=1}^{R-1} \frac{I_t}{(1+r)^t} + \frac{A[(1+r)^R - 1]}{r(1+r)^R} + \frac{\sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^R}$$

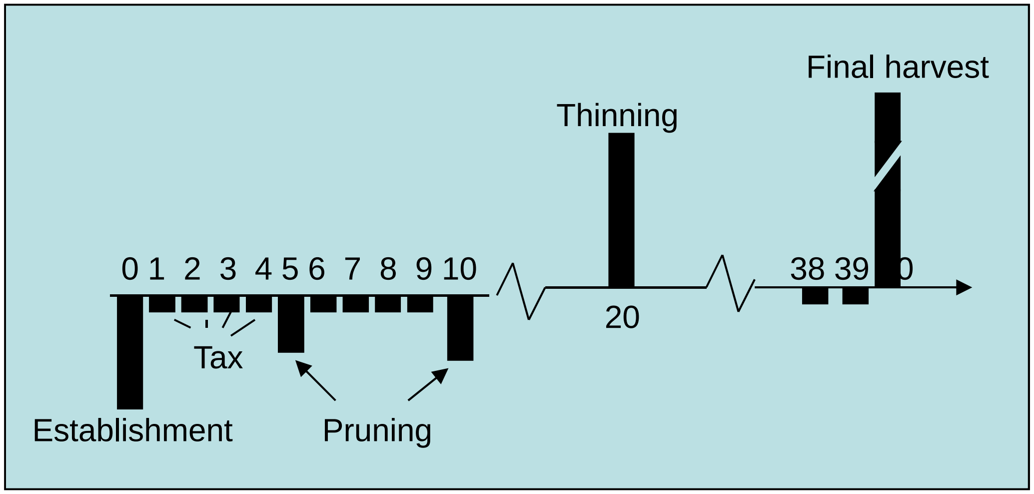
2. Convert the present value to a future value;

$$FV_{R_1} = (1+r)^R \cdot PV_{R_1}$$

3. Apply the infinite periodic payment formula

$$LEV = \frac{FV_{R_1}}{(1+r)^R - 1} =$$

Calculation of LEV



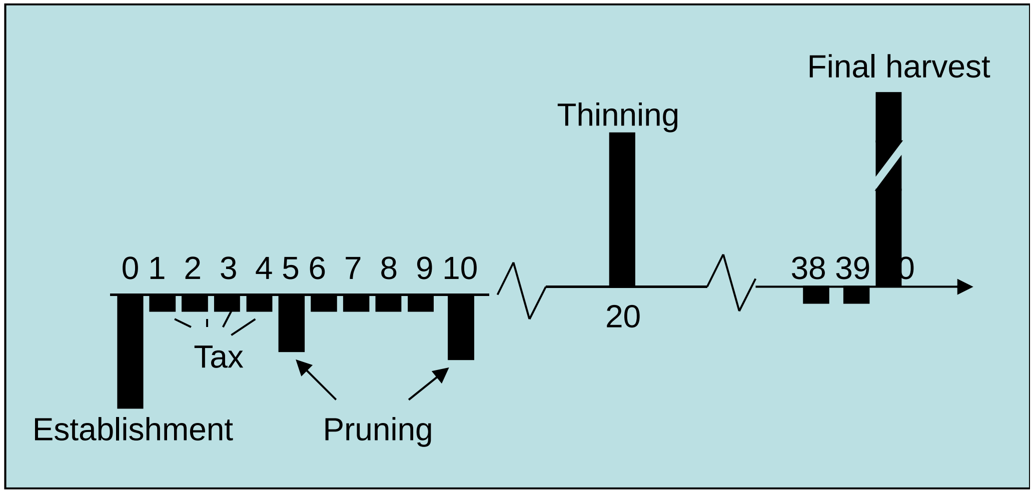
- <u>Method 2:</u>
  1. Calculate the future value of the first rotation;

$$FV_{R_1} = -E(1+r)^R + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \frac{A[(1+r)^R - 1]}{r} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h$$

  2. Apply the infinite periodic payment formula

$$LEV = \frac{FV_{R_1}}{(1+r)^R - 1} =$$

Calculation of LEV



- <u>Method 3:</u>
  1. Calculate the future value of the first rotation, ignoring the annual costs and revenues:

$$FV'_{R_1} = -E(1+r)^R + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h$$

  2. Apply the infinite periodic payment formula

$$LEV = \frac{FV'_{R_1}}{(1+r)^R - 1} + \frac{A}{r} =$$

A Loblolly Pine Example

Management Activity	Cost/Revenue ($/acre)	Timing	Present Value of First Rotation	Future Value of First Rotation
Reforestation	125.00	0	-$125.00	-$1,285.71
Brush control	50.00	5	-$37.36	-$384.30
Thinning cost	75.00	10	-$41.88	-$430.76
Thinning revenue	200.00	20	$62.36	$641.43
Property tax	3.00	annual	-$45.14	-$464.29
Hunting lease	1.00	annual	$15.05	$154.76
Final harvest	3,000.00	40	$291.67	$3,000.00
Total			**$119.69**	**$1,231.12**

Calculate the per acre LEV using a 6% real alternative rate of return.

- <u>Method 1</u>:
  1. Convert PV of 1st rotation to FV:

$$FV_{R_1} = PV_{R_1}(1+r)^{40} = \$119.69 \cdot (1.06)^{40} = \underline{\$1,231.12}$$

  2. Apply the infinite periodic payment formula for this future value:

$$LEV = \frac{FV_{R_1}}{(1+r)^R - 1} = \frac{\$1,231.12}{9.28571} = \underline{\underline{\$132.58}}$$

- <u>Method 2</u>: is identical to Step 2 in Method 1;

- **Method 3**:
  1. Calculate FV of 1st rotation without annual costs/revenues :

$$FV'_{R_1} = -\$1,285.71 - \$384,30 - \$430.76 +$$
$$+ \$641.43 + \$3,000 = \underline{\$1,540.66}$$

  2. Apply the infinite periodic payment formula for this future value:

$$LEV' = \frac{\$1,540.66}{(1.06)^{40} - 1} = \underline{\$165.9172}$$

  3. Apply and deduct the infinite annual series of net revenues:

$$LEV = LEV' + \frac{A}{r} = \$165.9172 + \frac{-\$2}{0.06} = \underline{\underline{\$132.58}}$$

$$LEV = \frac{\left[-E + \sum_{t=1}^{R-1} \frac{I_t}{(1+r)^t} + \frac{A[(1+r)^R - 1]}{r(1+r)^R} + \frac{\sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^R} \right] (1+r)^R}{(1+r)^R - 1}$$

$$LEV = \frac{-E(1+r)^R + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \frac{A[(1+r)^R - 1]}{r} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^R - 1}$$

$$LEV = \frac{-E(1+r)^{R} + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^{R} - 1} + \frac{A}{r}$$

$$FV_{reforestation} = -E(1+r)^{R} = -\$125.00 \cdot (1.06)^{40} = \underline{-\$1,285.71}$$

$$PV_{brush} = I_5(1+r)^{-5} = -\$50.00 \cdot (1.06)^{-5} = \underline{-\$37.36}$$

$$FV_{brush} = I_5(1+r)^{(R-5)} = -\$50.00 \cdot (1.06)^{35} = \underline{-\$384.30}$$

$$PV_{tax} = \frac{A_{tax}[(1+r)^R - 1]}{r(1+r)^R} = \frac{-\$3.00[(1.06)^{40} - 1]}{0.06(1.06)^{40}} =$$

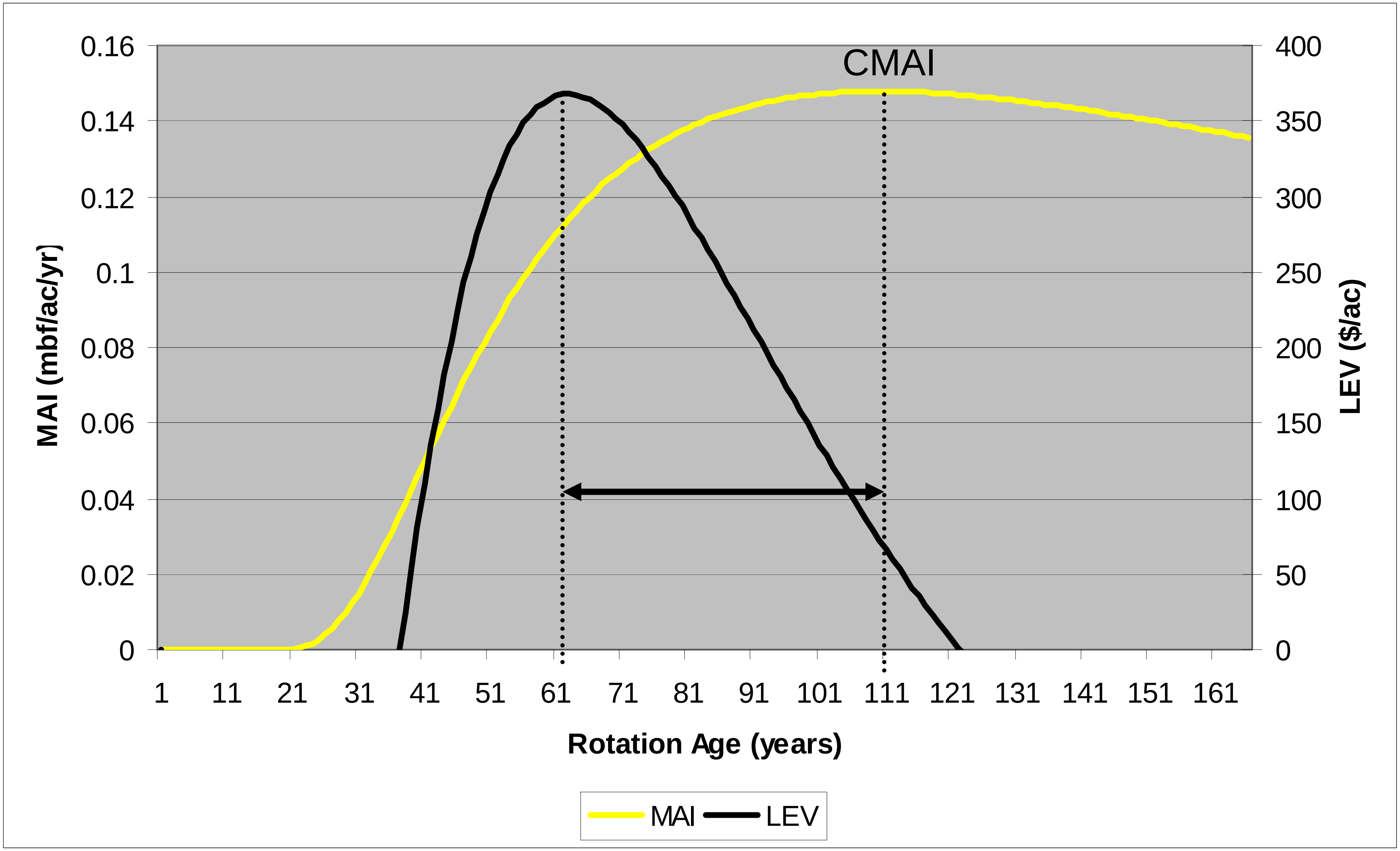
$$= \frac{-\$27.8571}{0.61714} = \underline{-\$45.14}$$

$$FV_{tax} = \frac{A_{tax}[(1+r)^{R} - 1]}{r} = \frac{-\$3.00[(1.06)^{40} - 1]}{0.06} =$$

$$= \frac{-\$27.8571}{0.06} = \underline{-\$464.29}$$

$$PV_{harvest} = \frac{\sum_{p=1}^{n} P_p Y_{p,R} - C_h}{(1+r)^R} = \frac{\$3000.00}{1.06^{40}} = \underline{-\$291.67}$$

LEV and MAI



CMAI
MAI (mbf/ac/yr)
LEV ($/ac)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
400
350
300
250
200
150
100
50
0
1 11 21 31 41 51 61 71 81 91 101 111 121 131 141 151 161
Rotation Age (years)
MAI
LEV

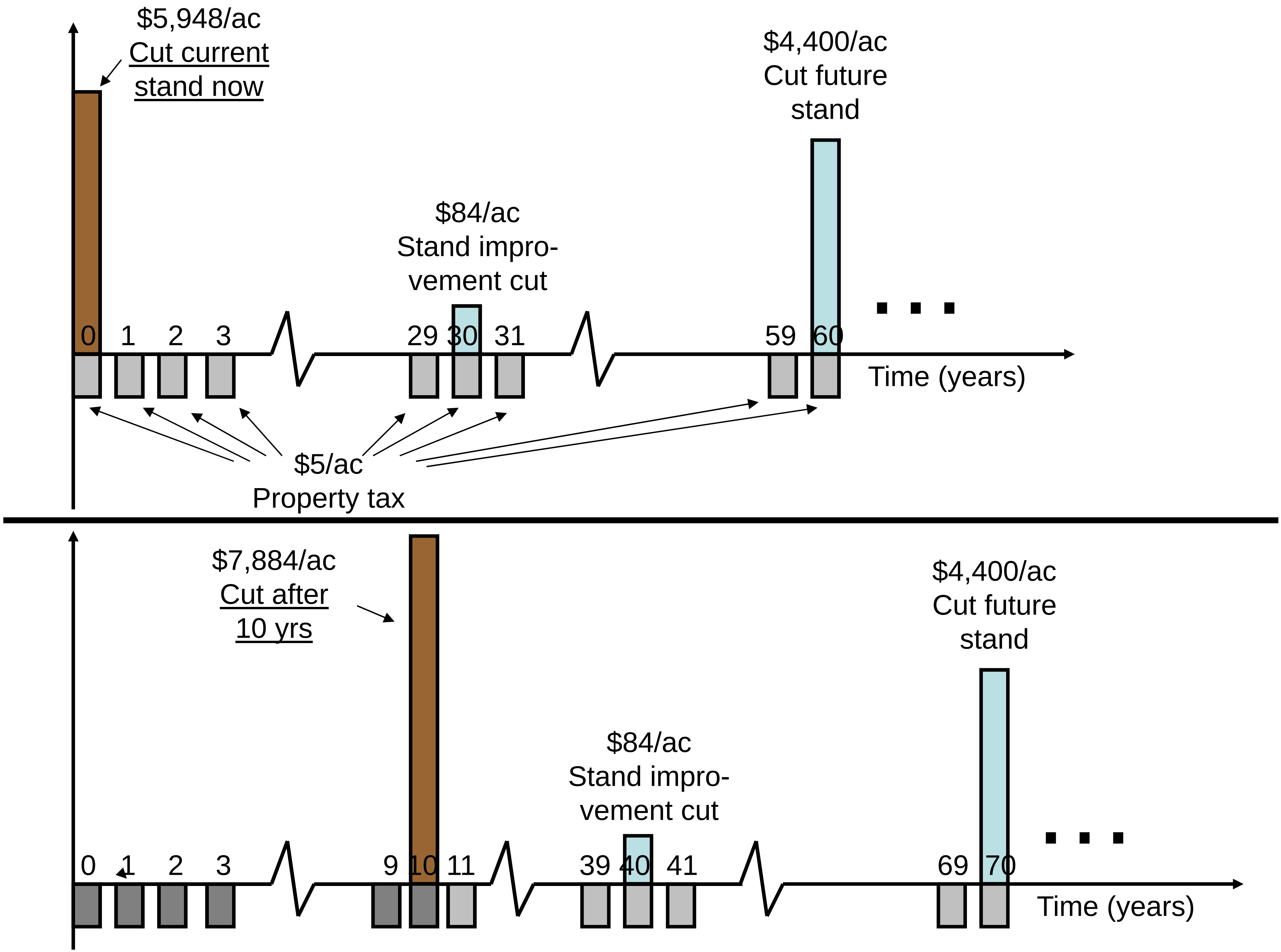
- Land Expectation Value: present value of costs and revenues from an infinite series of identical even-aged forest rotations starting from bare land;

- Forest Value (a generalization of LEV): the present value of a property with an existing stand of trees + the present value of a LEV for all future rotations of timber that will be grown on the property after harvesting the current stand.

The Forest Value allows us:

- To determine when a given stand should be cut;
- To separate the management of the current stand from that of future stands;
- To account for price changes that might occur during the life of the current stand;

Note: We will still assume that the rotations and prices associated with the future stands (i.e., the stands that are established after the current stand is cut) will be the same.


$5,948/ac
Cut current stand now
$4,400/ac
Cut future stand
$84/ac
Stand improvement cut
0
1
2
3
29
30
31
59
60
Time (years)
$5/ac
Property tax
$7,884/ac
Cut after 10 yrs
$4,400/ac
Cut future stand
$84/ac
Stand improvement cut
0
1
2
3
9
10
11
39
40
41
69
70
Time (years)

When to cut the stand?

- <u>Cut it now:</u>
  - Forest Value = $\underbrace{\text{Current Timber Value}}_{\text{\$5,948/ac}}$ + LEV

$$LEV = \frac{-E(1+r)^R + \sum_{t=1}^{R-1} I_t (1+r)^{(R-t)} + \sum_{p=1}^{n} P_p \cdot Y_{p,R} - C_h}{(1+r)^R - 1} + \frac{A}{r} =$$

$$= \frac{\$84(1.05)^{(60-30)} + \$4,400}{(1.05)^{60} - 1} - \frac{\$5}{0.05} =$$

$$= \frac{\$363.04316 + \$4,400}{17.67919} - \$100 = \underline{\$169.42 / ac}$$

$$FV_0 = \$5,948 / ac + \$169.42 / ac = \underline{\underline{\$6,117.42 / ac}}$$

When to cut the stand?

- <u>Cut it 10 years from now:</u>
  - Forest Value = Present Value of Costs and Revenues for first 10 years + Present Value of LEV

$$PV_{LEV} = \frac{LEV}{(1+0.05)^{10}} = \frac{\$169.42}{1.62889} = \underline{\$104.01/ac}$$

$$PV_{CurrentRotation} = \frac{\$7,884}{(1.05)^{10}} - \frac{\$5(1.05^{10}-1)}{0.05(1.05)^{10}} =$$

$$= \$4,840.09 - \$38.61 = \underline{\$4,801.48/ac}$$

$$FV_{10} = PV_{CurrentRotation} + PV_{LEV} = \underline{\underline{\$4,905.49/ac}}$$

Forest Value

- Assumptions:
  1. The current stand will be harvested;
  2. A new stand will be established;
  3. All future rotations of the new stand will be identical.

- Definition:
  – The *Forest Value* is the present value of the projected costs and revenues from an existing forest tract, plus the present value of an infinite series of identical future forest rotations that starts after the current tract is harvested.

Calculating the Forest Value

- New notation:

T_0 = the time when the currect stand is to be cut;

Y^{C}_{p,T_0} = the expected yield of product p from the current stand at time T_0; and

C^{C}_{h} = the cost of selling the current stand of timber.

- Forest Value formula:

$$FV = \underbrace{\frac{\sum_{p=1}^{n} P_p \cdot Y^{C}_{p,T_0} - C^{C}_{h}}{(1+r)^{T_0}}}_{\substack{\textit{Net present value} \text{ of harvest revenues} \\ \text{from the current stand}}} + \underbrace{\frac{A[(1+r)^{T_0} - 1]}{r(1+r)^{T_0}}}_{\substack{\textit{Net} \text{ present value of annual} \\ \text{revenues up to when the current} \\ \text{stand is cut}}} + \underbrace{\frac{LEV}{(1+r)^{T_0}}}_{\substack{\textit{Discounted} \text{ LEV} \\ \text{of future rotations}}}$$

Land value and timber value

- Forest Value = Land Value + Timber Value
  - Land Value = LEV
  - Timber Value = Forest Value – LEV

$$Timber\ Value = \frac{\sum_{p=1}^{n} P_p \cdot Y_{p,T_0}^{C} - C_h^{C}}{(1+r)^{T_0}} - \frac{\overbrace{(r \cdot LEV - A)}^{Annual\ Land\ Cost} \cdot [(1+r)^{T_0} - 1]}{r(1+r)^{T_0}}$$

What if real prices change?

- <u>Assumption</u>: the price changes will end by the end of the current rotation

$$Timber\ Value = \frac{\sum_{p=1}^{n} P_{p,T_0} \cdot Y_{p,T_0}^{C} - C_h^C}{(1+r)^{T_0}} - \frac{\overbrace{(r \cdot LEV - A)}^{Annual\ Land\ Cost} \cdot [(1+r)^{T_0} - 1]}{r(1+r)^{T_0}}$$

When calculating the LEV, use the new, steady state price: $P_{p,\infty}$

An example

Item	Amount
Assumptions for the Current and Future Stands	
Current sawtimber volume	18 mbf/ac
Current pulpwood volume	14 cords/ac
Current sawtimber price	$325/mbf
Current pulpwood price	$7/cord
Expected sawtimber volume in 10yrs	24 mbf/ac
Expected pulpwood volume in 10yrs	12 cords/ac
Expected real sawtimber price in 10yrs	$450/mbf
Expected real pulpwood price in 10yrs	$15/cord
Property tax	$5
Real alternate rate of return	5%
Assumptions for the Current and Future Stands	
Timber stand improvement cut (age 30 yrs) pulpwood harvest	12 cords/ac
Final (age 60) sawtimber harvest	13 mbf/ac
Final (age 60) pulpwood harvest	25 cords/ac

Cut now:

$$Timber\ \ value = \sum_{p=1}^{2} P_{p,0} \cdot Y_{p,0}^{C} = \$325\,/\,mbf\ \cdot 18mbf\ + \$7\,/\,cd\ \cdot 14cd\ = \$5,948$$

$$FV'_{R1} = 12 \cdot \$15 \cdot (1.05)^{30} + 13 \cdot \$450 + 25 \cdot \$15 = \$7,002.95$$

$$LEV = \frac{FV'_{R1}}{(1+r)^{R} - 1} - \frac{tax}{r} = \frac{\$7,002.95}{(1.05)^{60} - 1} - \frac{\$5}{0.05} = \$296.11$$

$$ForestValue_{CutNow} = \$5,948 + \$296.11 = \underline{\underline{\$6,244.13}}$$

Cut in 10 yrs:

$$Timber\ \ value = \sum_{p=1}^{2} P_{\ p,10} \cdot Y_{p,10}^{C} = \$450\ /\ mbf\ \cdot 24 mbf\ + \$15\ /\ cd\ \cdot 12 cd\ = \$10,980$$

$$PV_{timber} = \frac{\$10,980}{(1.05)^{10}} - \$38.61 = \$6,740.77 - \$38.61 = \$6,702.16$$

$$PV_{LEV} = \frac{\$296.11}{(1.05)^{10}} = \$181.79$$

$$ForestValue_{CutIn10yrs} = \$6,702.16 + \$181.79 = \underline{\underline{\$6,883.95}}$$