# National Exams May 2012
# 04-For-A4, Forest Management

## 3 hours duration

This exam addresses the following topics:

**Forest dynamics.**
**Modelling forests and examining their change with and without intervention.**
**Decision-making processes used to manage change in forests.**

NOTES:

1. If doubt exists as to the interpretation of any question, you are urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM. Any non-communicating calculator is permitted.

3. Answer questions in the space provided in this exam paper.

4. Answer questions 1,2,5,7, and 8 and two of questions 3,4, and 6.

5. Question scoring values are:

| | | |
|---|---|---|
| [1] | = | 14 |
| [2] | = | 14 |
| [3] | = | 12 |
| [4] | = | 12 |
| [5] | = | 20 |
| [6] | = | 12 |
| [7] | = | 16 |
| [8] | = | 12 |

6. Show calculations where appropriate.

*[14 marks]*

[1] Over the past two decades ecosystem management has replaced sustained yield and multiple-use as the guiding paradigm for forest management in many parts of North America.

**Briefly, but clearly, state the key principles of ecosystem management and the fundamental ways by which it differs from sustained yield and multiple-use management.**

*[14 marks]*

[2] An industrial forest license holder has proposed a forest management strategy for a Crown (publicly-owned) forest management agreement area. You have been asked to evaluate that strategy in terms of its "sustainability".

**Describe three basic considerations would you make and state the criteria for each you would use to assess the sustainability of the strategy.**

*[12 marks]*

[3] Eight forests of similar composition and initial age structure are each affected through time by a different disturbance regime. The disturbance regimes are characterized by disturbance type, disturbance frequency, and disturbance allocation across age classes in the forest (Table 1). The forest age class structures resulting after 200 years of disturbance as defined in Table 1 are shown in Figures 1-8.

**Record in Table 1, the number of the figure illustrating the forest age class structure most likely to have resulted from each disturbance regime.**

Table 1.

| Disturbance Regime Characteristics | | | |
|---|---|---|---|
| type | frequency | allocation across age classes | Figure # |
| clearcut harvest | 2% of forest area is harvested each year | oldest stands are harvested first | |
| stand-replacing fire | 2% of area burns each year | stands of all ages are equally likely to burn | |
| clearcut harvest | based on a rotation age of 80 years | oldest stands are harvested first | |
| clearcut harvest | 0.83% of forest area is harvested each year | oldest stands are harvested first | |
| stand-replacing fire | fire cycle of 200 years | stands of all ages are equally likely to burn | |
| stand-replacing fire | fire cycle of 120 years | stands of all ages are equally likely to burn | |
| clearcut harvest | 0.5% of forest area is harvested each year | oldest stands are harvested first | |
| stand-replacing fire | 1.25% of forest area burns each year | stands of all ages are equally likely to burn | |

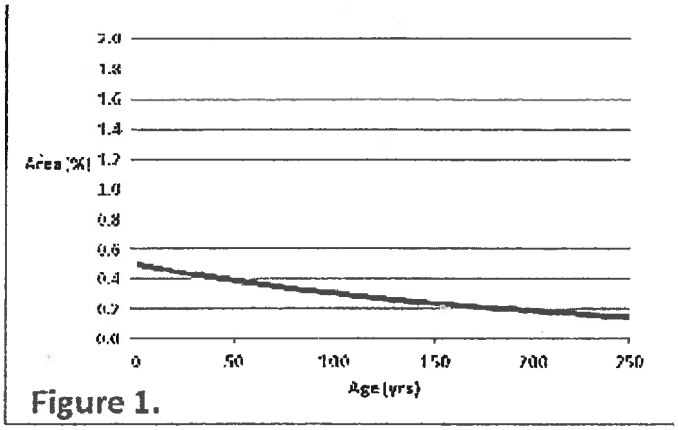



Figure 1.

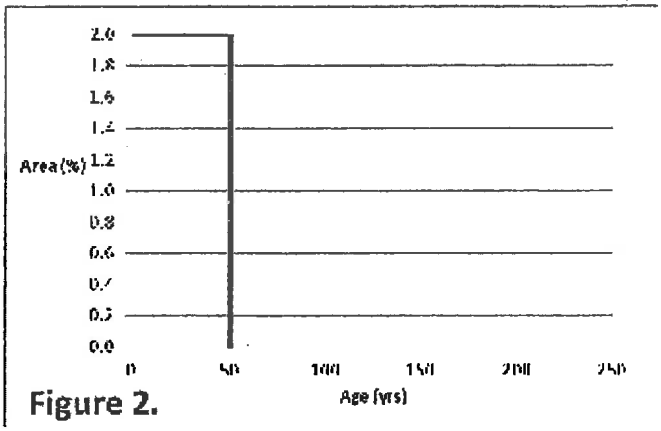



Figure 2.

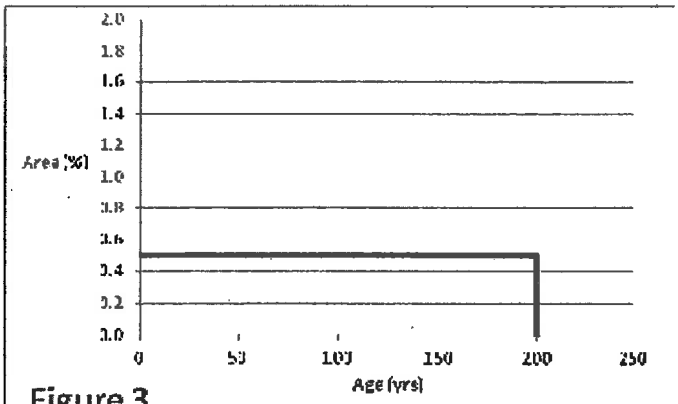



Figure 3.

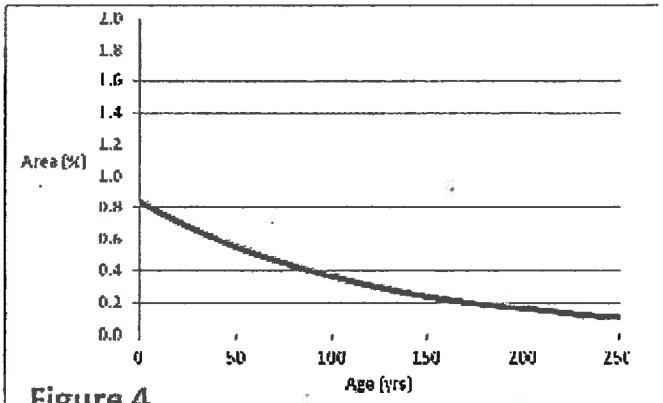



Figure 4.

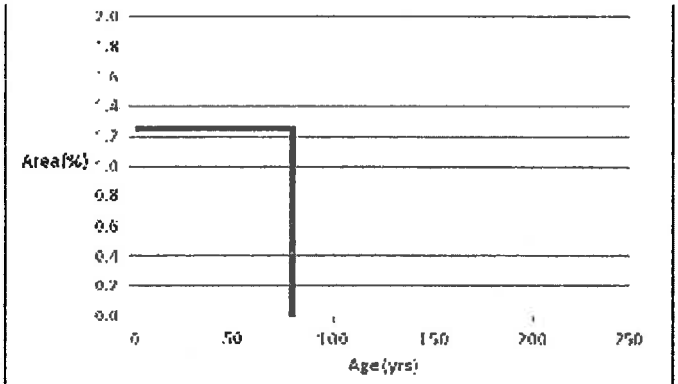



Figure 5.

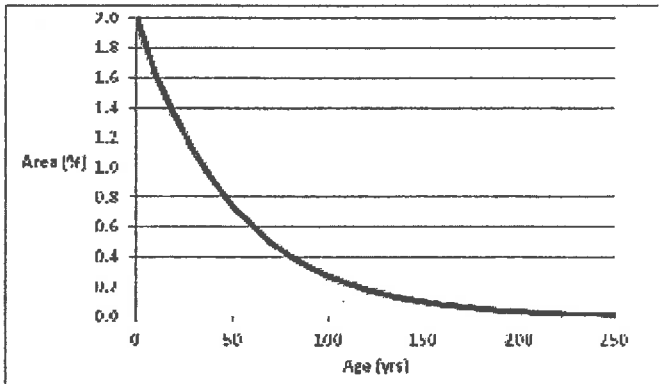



Figure 6.

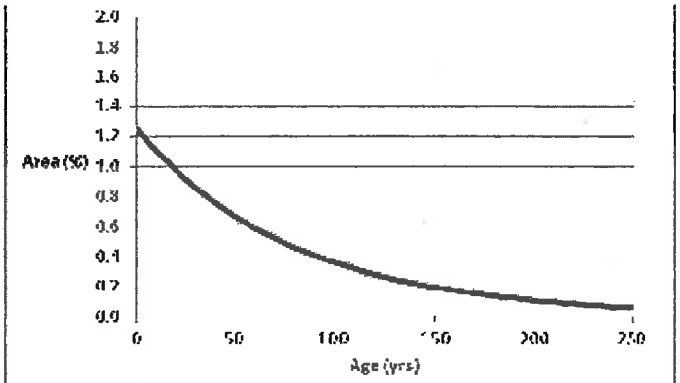



Figure 7.

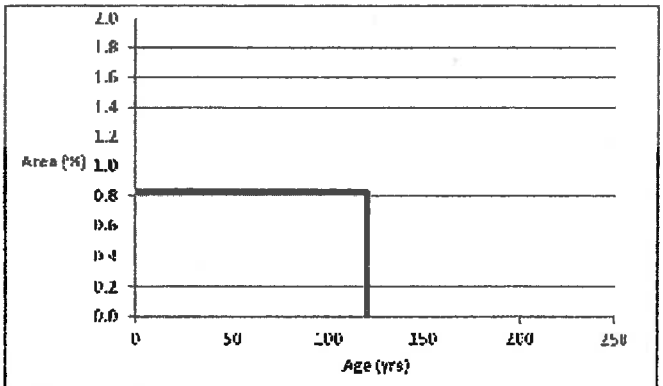



Figure 8.

*[12 marks]*

[4] Five people have conducted a strategic analysis for the same forest. All use linear programming and, except as stated in Table 2, all model setups are identical. There are three possible treatments (A,B,C) and the five analysts made various ones ***eligible for use*** in their analysis as stated in the table. There are three possible constraints (X,Y,Z) and the five analysts ***applied different ones*** as stated in the table.

Table 2. Analysis specifications .

| Analyst | Treatment Eligibility | | | Constraints Applied | | |
|---|---|---|---|---|---|---|
| | A | B | C | X | Y | Z |
| Willy | yes | no | no | yes | yes | no |
| Bob | yes | yes | no | yes | no | no |
| Tony | yes | yes | yes | yes | no | no |
| Tina | yes | no | no | yes | no | no |
| Leah | yes | no | no | yes | yes | yes |

Each analyst constructed the trade-off relationship between two indicators (Indicator 1 and Indicator 2); for each indicator, the higher the value the better management objectives are satisfied.

The five trade-off relationships the analysts constructed are shown in Figure 9.

Note: The ***only differences*** between the analysts' analyses is in which of the three treatments are made eligible for use and which of the three constraints are applied (Table 2).

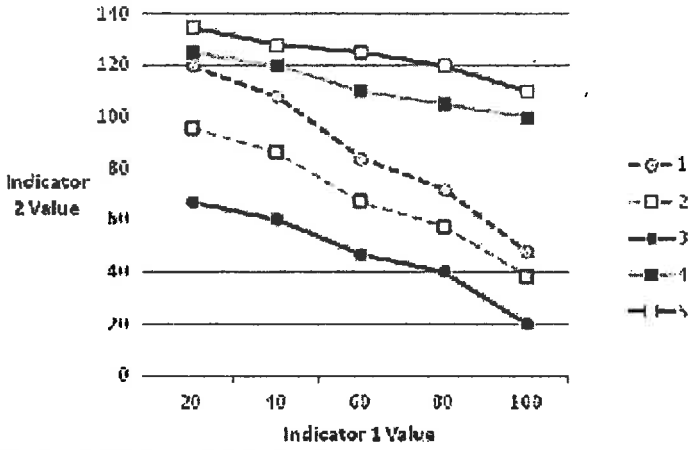



Fig 9. Trade-off between Indicator 1 and 2

| **Enter below the number of the trade-off relationship most likely to have been constructed by each analyst.** | |
|---|---|
| Analyst | Trade-off Relationship Number |
| Willy | |
| Bob | |
| Tony | |
| Tina | |
| Leah | |

*[20 marks]*

[5] The spotted nerf is a brilliantly plummaged forest bird with peculiar habits. Nerfs mate for life and each pair requires 1 ha of nesting habitat, 1 ha of feeding habitat, ***and*** 1 ha of escape cover habitat (Table 3). **One ha of each habitat type is required per pair**. Nerf pair territories can abut, but they cannot overlap. **All suitable habitat is fully occupied by nerfs irrespective of spatial configuration**.

| Table 3. Spotted nerf habitat requirements | | |
|---|---|---|
| Feeding | Nesting | Escape |
| shrubs ≥ 10% | snags ≥ 10/ha | crown closure ≥ 80% |

You are managing a 45,000 ha forest; it is composed of one and only one stand type and has an initial age class structure as shown in Figure 10.

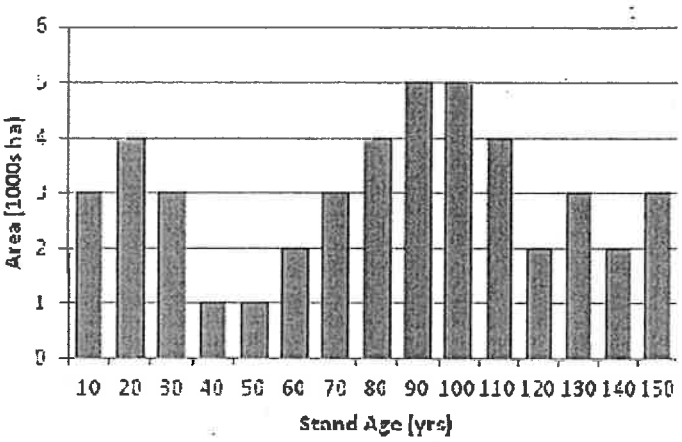



Fig 10. Forest age structure.

Stand development is shown in Figures 11-14. All stands aging past the 150 year old age class breakup and regenerate to age zero and all stands harvested regenerate to age zero and follow their pre-harvest development pattern. **Stands are operable (eligble) for harvest between 50 and 150 years of age (inclusive)**.

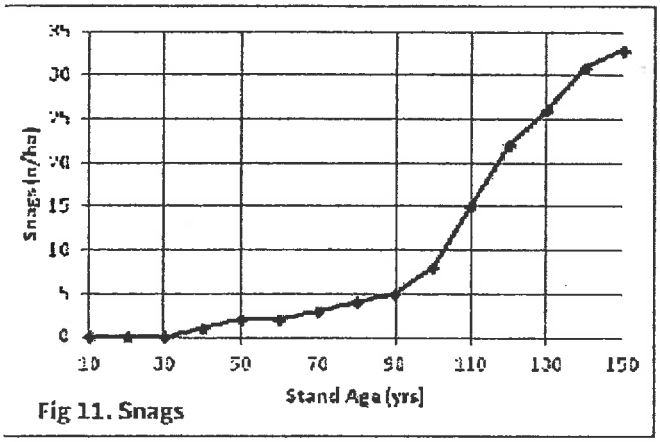



Fig 11. Snags

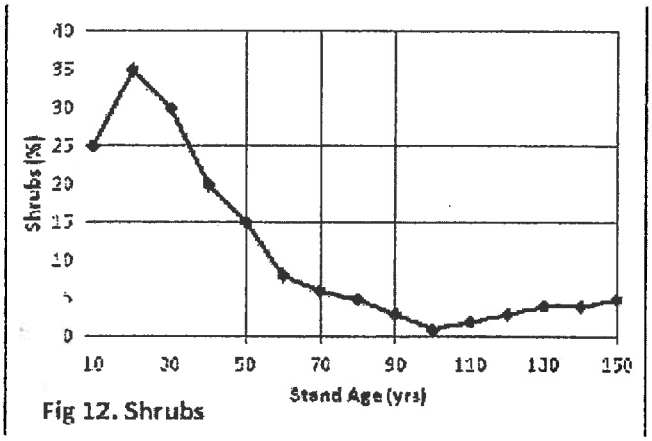



Fig 12. Shrubs

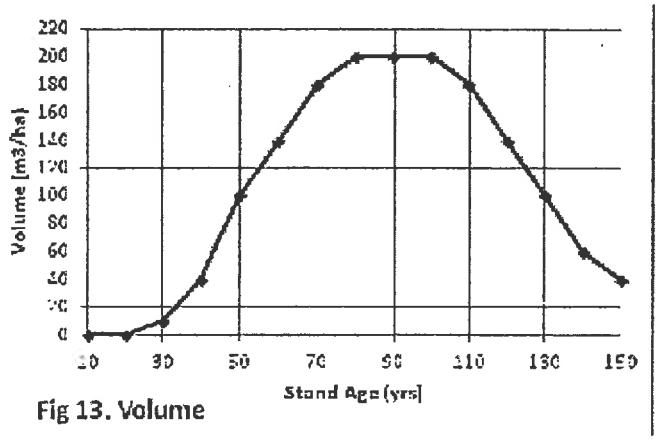



Fig 13. Volume

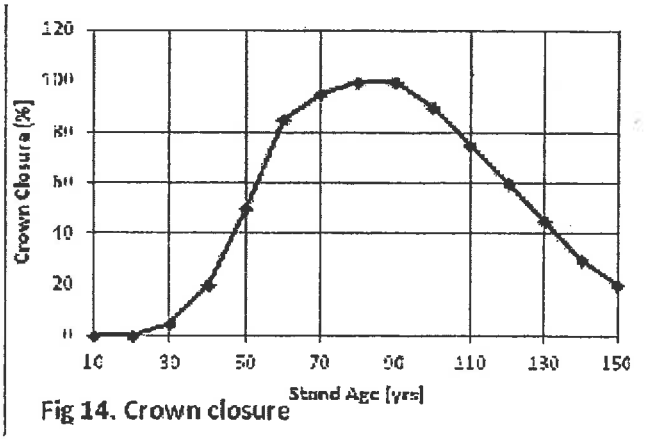



Fig 14. Crown closure

Assume you wish to harvest a total of 340,000 $m^3$ over the next 10 years (*i.e.* between 2012 and 2022) using clearcutting (in which all stand volume is harvested) and an oldest 1st harvest priority. In answering, use 10-year times steps and make the simplfying assumptions that volumes per age class are as shown (e.g. the current 50 year age class has a volume of 100 $m^3$/ha (Figure 13)) and that harvested stands enter the 10 year age class in the next period.

| ***5A - Define the harvest schedule that will accomplish your harvest objective.*** | ***[3 marks]*** |
|---|---|
| | |
| | |
| | |
| | |

| ***5B - After you implement that harvest schedule, what will be the nerf population be in 2022?*** | ***[5 marks]*** |
|---|---|
| | |
| | |
| | |

Assume you choose to manage this forest under an oldest first harvest priority while using the rotation age that maximizes long-term sustainable harvest volume.

| ***5C - Once the forest age structure stabilizes, how many pairs of nerfs will the forest be able to support?*** | ***[4 marks]*** |
|---|---|
| | |

Assume you wish to maintain a high nerf population.

| ***5D - What rotation age would you employ if you wanted to create in the future a forest condition that could support the highest possible nerf population?*** | ***[4 marks]*** |
|---|---|
| | |

| ***5E - What would the annual sustained harvest be under that strategy once the forest age structure stabilizes ?*** | ***[4 marks]*** |
|---|---|
| | |

*[12 marks]*

[6] A 1 hectare stand is planted today at a cost of $1000. It will be harvested at age 50 with a yield of 300 $m^3$/ha and a value of $25/$m^3$.

| **6A - Assuming a 6% interest rate, what is the net present value of the plantation?** *[6 marks]* |
|---|
| |
| |
| |
| |
| |

| **6B - What is the break-even interest rate? (i.e. the rate at which the net present value would equal zero)** *[6 marks]* |
|---|
| |
| |
| |
| |
| |

*[16 marks]*

[7] You design a management strategy for a 40 000 ha forest using the following basic information.

- The current forest age class structure is shown in Figure 16.
- Existing and post-clearcut naturally regenerating stands develop as shown by the Natural line in Figure 15 and are operable for harvest at age 60 years.

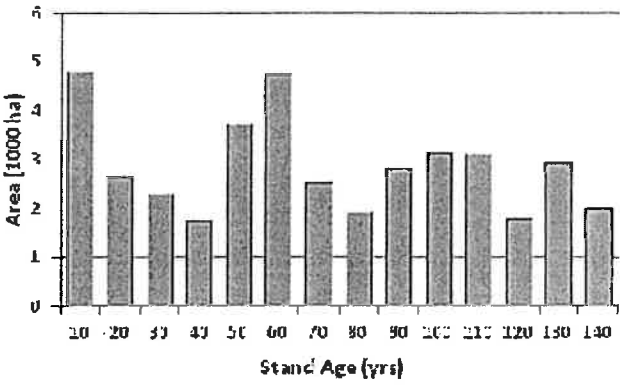



Fig 16. Forest age class structure.

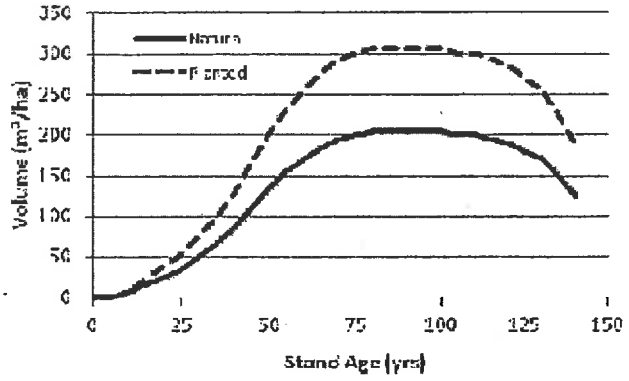



Fig 15. Stand volume development

- Plantations develop as shown by the Planted line in Figure 15 and are operable (*i.e.* first available) for harvest at age 50 years. No plantations exist at present.
- Value of standing operable timber is constant through time at $\$20/m^3$.
- All stand harvesting is by clearcutting and stands are ranked for harvest on an oldest first basis.
- 300ha/yr are planted and 100 000 $m^3$/yr are harvested.
- No volume is lost to fires, disease, or insects.

This will be called the Base Scenario and under this strategy the operable growing stock standing timber value is as shown in Figure 17.

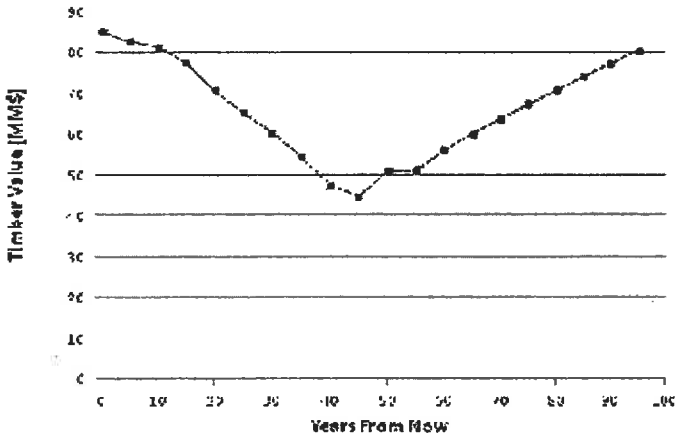



Fig 17. Operable growing stock standing timber value under the Base Scenario.

Eight modified scenarios are defined in Table 4. Each differs from the Base Scenario **in one and only one way** as described in the table.

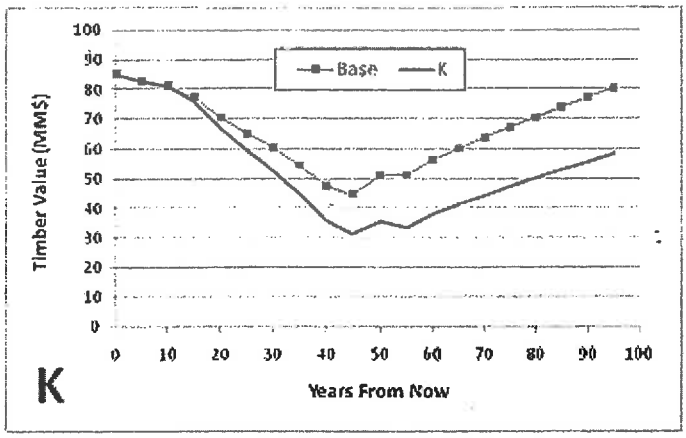
The 8 figures on page 27 show operable growing stock timber value for the base strategy through time, together with that for one of the modified scenarios (designated with a letter).

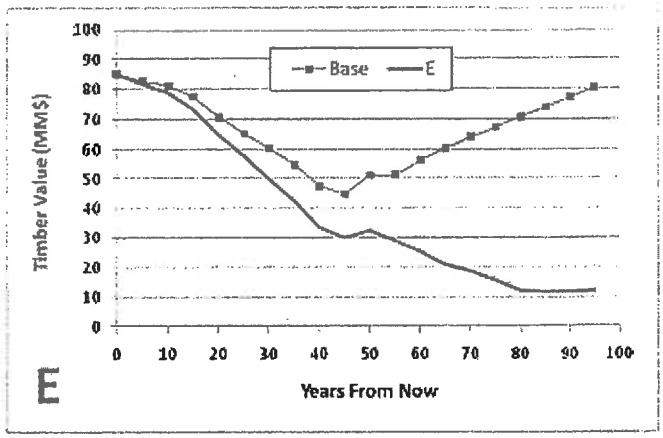
Enter in the 2nd column of Table 4 the letter of the operable growing stock timber value profile that is most likely to result under each modified management scenario. There is a ***one-to-one*** relationship between management scenarios and timber value profiles Interest rate question.

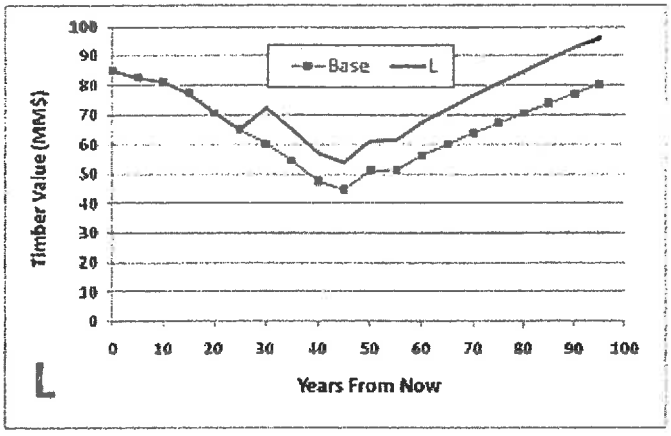
**Table 4. Description of modified scenarios stating the sole difference from the Base Scenario.**

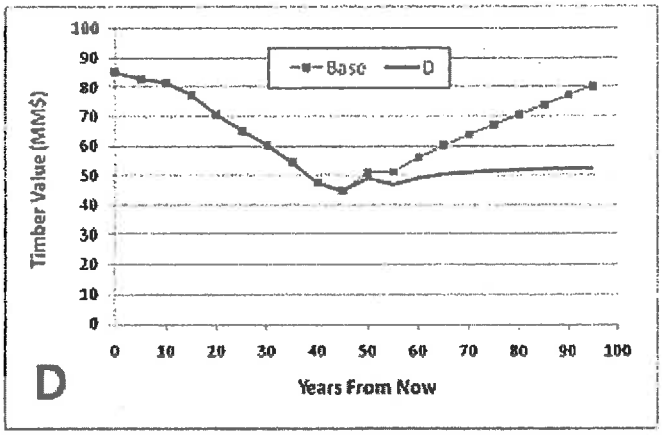
| Modified Scenarios [see footnote] | Figure Letter |
|---|---|
| fire burns 1000 ha next year; 2000 ha 25 years from now, and 1000 ha 50 years from now; oldest stands burn; burned stands regenerate to age zero and follow the Natural pattern of development; no timber salvaged | |
| 33% of volume in all plantations is deemed inoperable because it is to be left unharvested to provide structural diversity | |
| 300 ha/yr of existing and future 15 year old Natural stands are killed by disease; these stands regenerate to age zero and follow the Natural pattern of development | |
| for the next 50 years 80 ha/yr of oldest age classes are designated as permanently protected area and removed from the operable landbase | |
| 100 ha/yr of existing and future 45 year old natural stands are killed by disease; these stands regenerate to age zero and follow the Natural pattern of development | |
| stands are ranked for harvest priority based on descending increment of stumpage value (age classes with highest stumpage increments ranked first) | |
| more aggressive site preparation and competition control are used in plantations which reduces time to harvest operability by 10 years | |
| stumpage value increases by 20% 30 years from now in response to engineering breakthrough in using wood in construction of tall buildings | |

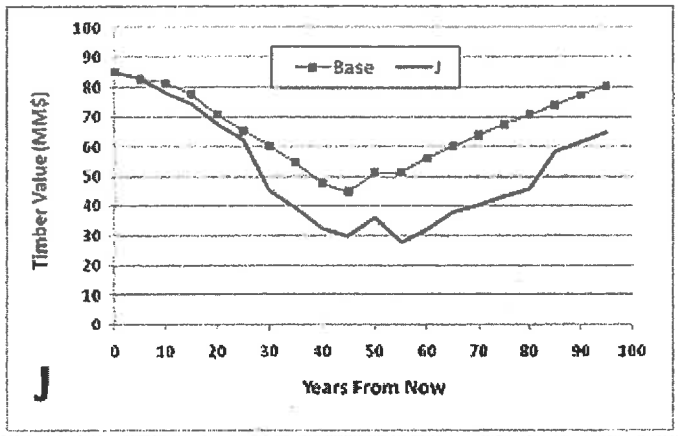
Footnote Except as noted all modified scenarios commence immediately after time zero on graphs.

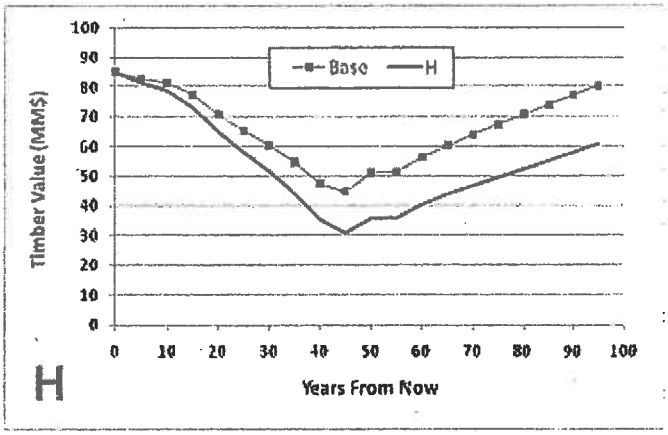

Base
K
Timber Value (MM$)
Years From Now
K


Base
E
Timber Value (MM$)
Years From Now
E


Base
L
Timber Value (MM$)
Years From Now
L


Base
D
Timber Value (MM$)
Years From Now
D


Base
J
Timber Value (MM$)
Years From Now
J


Base
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Timber Value (MM$)
Years From Now
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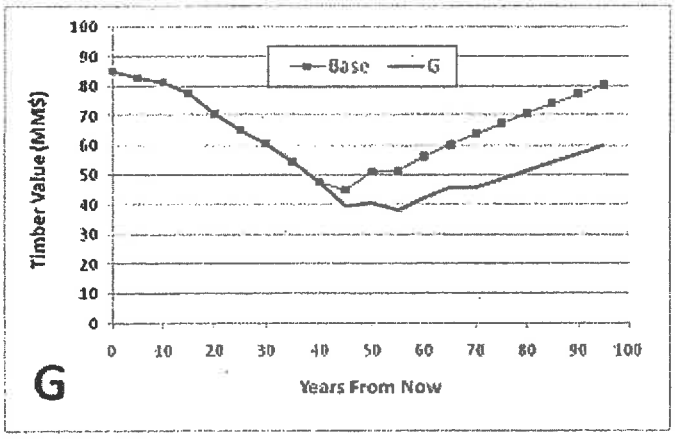
Base
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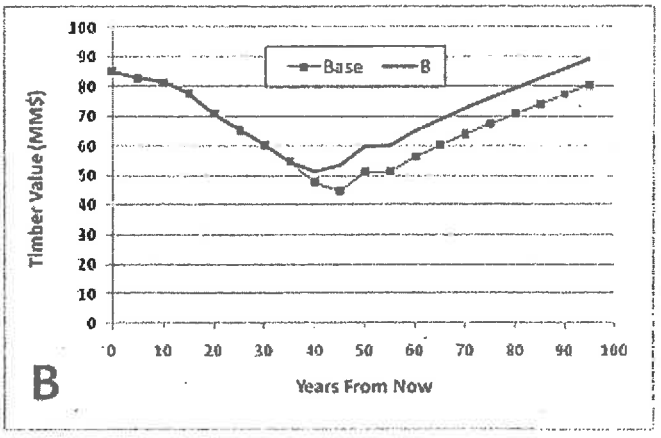
Timber Value (MM$)
Years From Now
G


Base
B
Timber Value (MM$)
Years From Now
B

*[12 marks]*

[8] A forest is made up of only one stand type. Its volume development is illustrated in Figure 18. Your friend devises a management strategy for the forest which results in area and volume harvested

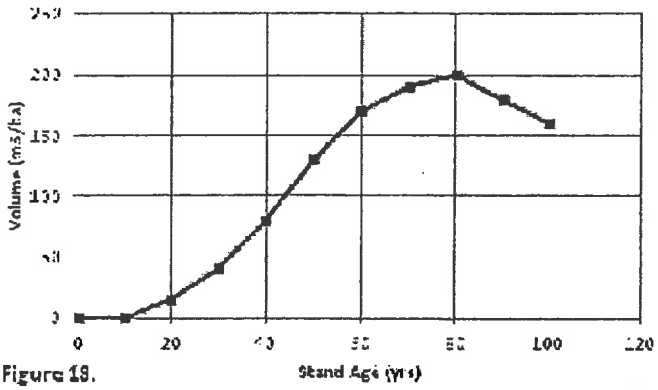



Figure 18.

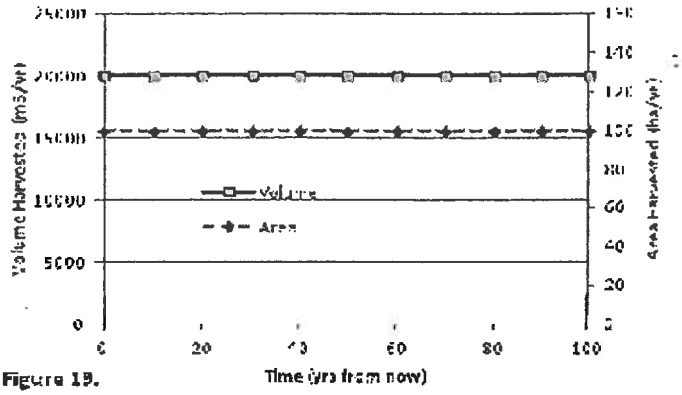



Figure 19.

through time as shown in Figure 19. Oldest stands are harvested first and all harvested stands regenerate follow the development pattern in Figure 18.

***Draw in Figure 20 the most probable initial age class structure for that forest.***

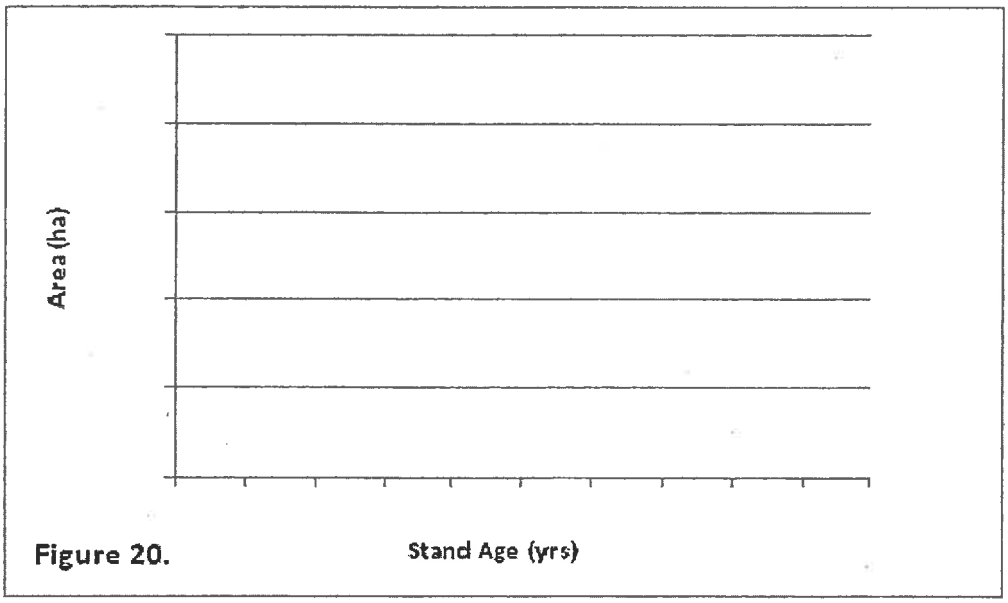



Figure 20.