National Exams May 2011
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 a closed BOOK EXAM. A Casio of Sharp approved calculator is permitted.

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

4. Answer questions [1], [3], [5], [7], and [8].
   Answer any 2 of questions [2], [4], and [6]

5. Question scoring values are:
   [1] = 12
   [2] = 10
   [3] = 16
   [4] = 10
   [5] = 18
   [6] = 10
   [7] = 20
   [8] = 14

6. Show calculations where appropriate.

[1] Natural disturbance-based forest management is practised in some jurisdictions of North America as a means to protect native biological diversity. Such management aims to maintain forest conditions within the range of historical variation.

Briefly, but clearly, state the key underpinning logic by which natural disturbance-based management is believed an effective approach to protecting biological diversity. ***[12 marks]***

[2] Four alternate management strategies (numbered 1-4) are designed for a forest using linear programming and a 100-year planning horizon. All strategies use a non-declining harvest volume constraint and an objective function to maximize net present value. Net present value is based on revenue from sale of harvest volume.

The four strategies differ only in terms of discount interest rate used to calculate net present value. The resulting harvest volume profiles through time are shown for all strategies in Figure 1.

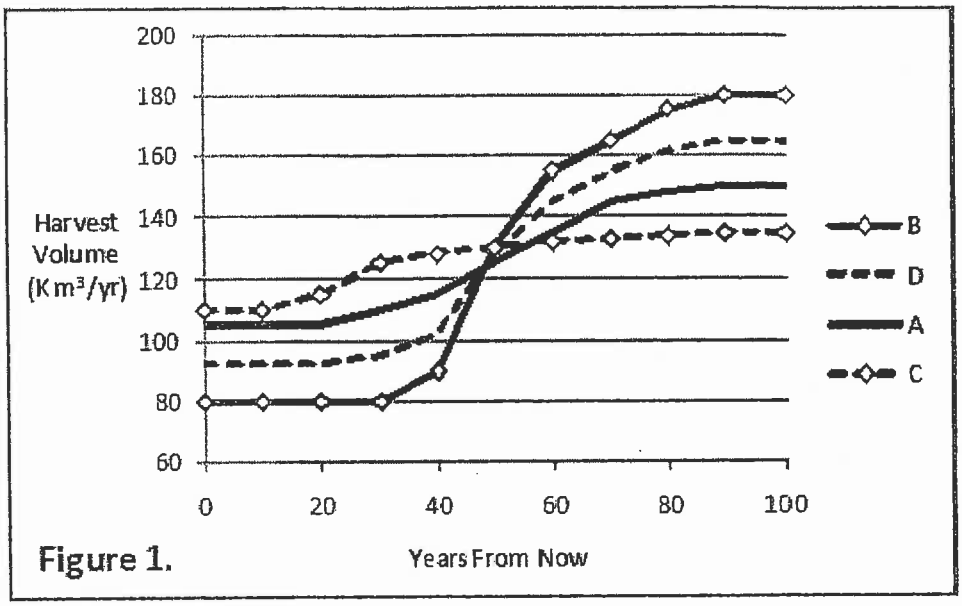

Figure 1.

Record in the last row of Table 1 the letter of the harvest volume profile in Figure 1 most likely to result under each strategy. ***[10 marks]***

Table 1.

Strategy	1	2	3	4
Interest rate used to calculate net present value	0%	2%	4%	8%
Letter of harvest profile in Figure 1.				

[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 2). The forest age class structures resulting after 100 years of disturbance as defined in Table 2 are shown in Figures 2-9.

Record in Table 2, the number of the figure illustrating the forest age class structure most likely to have resulted from each disturbance regime. ***[12 marks]***

Table 2.

Disturbance Regime Characteristics			
type	frequency	allocation across age classes	Figure #
clearcut harvest	1% of forest area is harvested each year	stands greater than 60 years old are randomly harvested	
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 100 years	oldest stands are harvested first	
clearcut harvest	1.5% of forest area is harvested each year	stands greater than 60 years old are randomly harvested	
stand-replacing fire	1% of area burns each year	stands of all ages are equally likely to burn	
clearcut harvest	based on a rotation age of 50 years	oldest stands are harvested first	
clearcut harvest	based on a rotation age of 70 years	oldest stands are harvested first	
clearcut harvest	1% of forest area is harvested each year	stands greater than 80 years old are randomly harvested	

Which figure contains the forest structure you would recommend if a forest with a 100 year natural fire cycle is to be managed for sustained timber production using principles of natural disturbance-based management? Justify your choice ***[4 marks]***

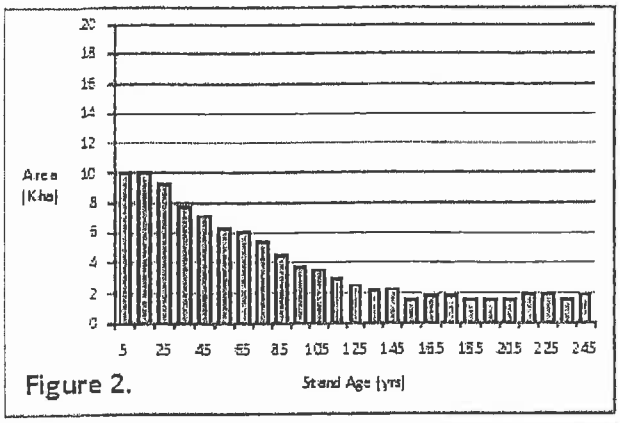

Figure 2.

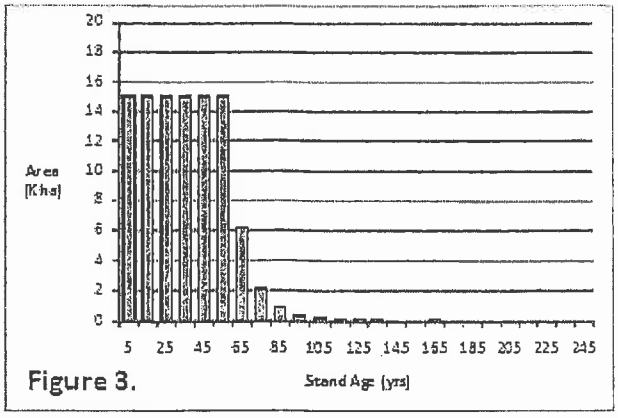

Figure 3.

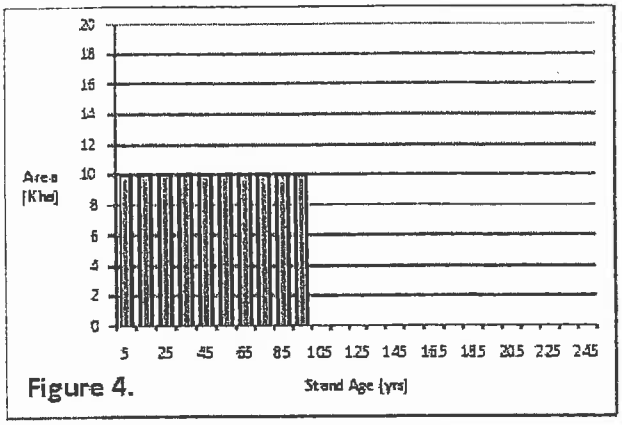

Figure 4.

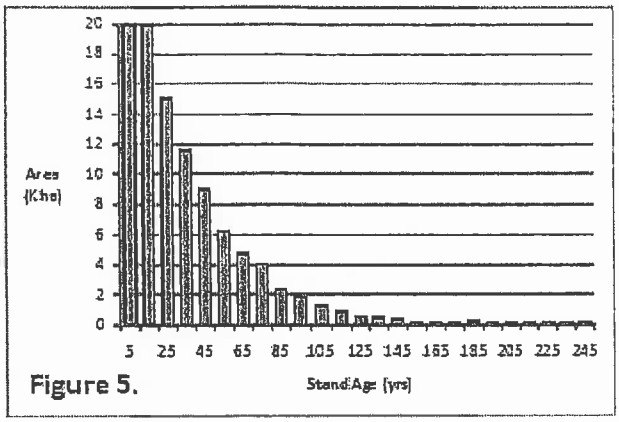

Figure 5.

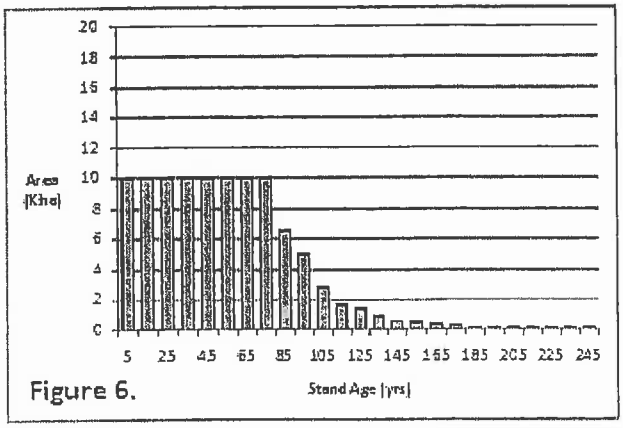

Figure 6.

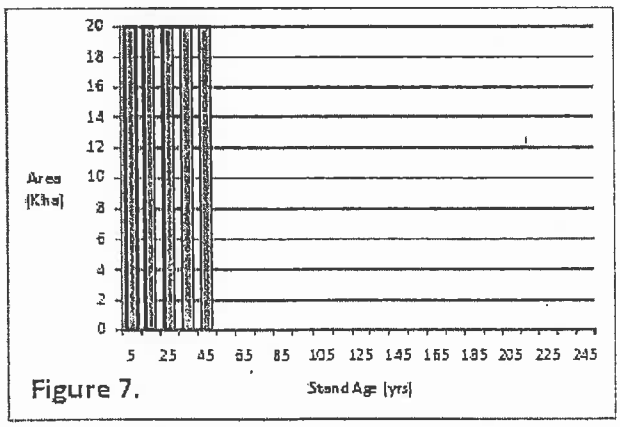

Figure 7.

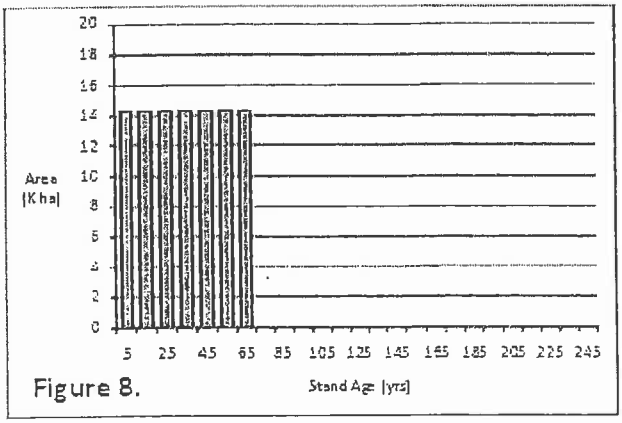

Figure 8.

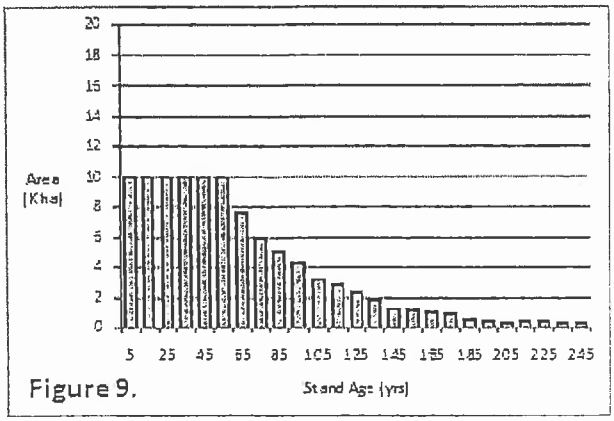

Figure 9.

[4] A forest management plan is to be designed using linear programming. You are particularly interested in managing the forest to provide old forest habitat. You are offered two choices: You can choose to address your old forest objectives in the management strategy by either including it in the linear programming objective function or in the linear programming constraints.

Assuming you want your objectives for old forest to have maximum influence on the management plan which choice would you make? State your choice and present a compelling argument for it. ***[10 marks]***

[5] You develop management strategies for a 4800 ha forest which has an irregular age structure at present. It is composed of one stand type with total volume and sawlog yields as shown in Figure 10. Your strategies employ only clearcut harvesting, an "oldest first" harvest rule, and equal area harvested per year. Assume all harvested stands revert to age zero and grow according to their original development pattern (*i.e.* that shown in Figure 10).

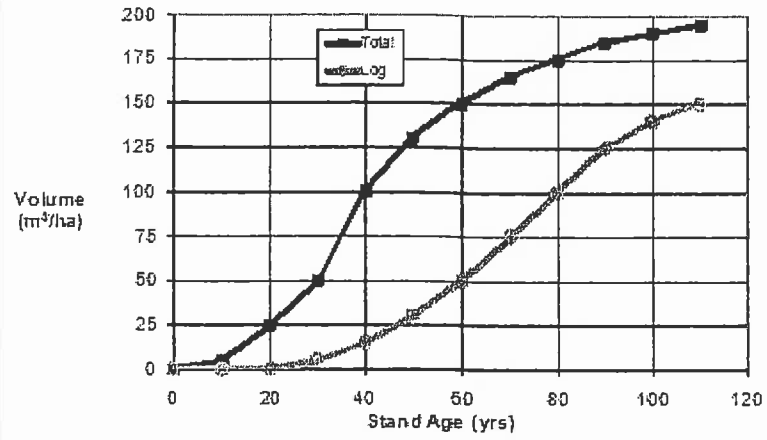

Fig 10. Total and log volume yields.

You have also determined suitable habitat conditions for four species and expressed them in terms of total stand volume as follows:

Common Yellowthroat:	total stand volume ≤ 25 m^3/ha
Parula Warbler:	total stand volume >25 m^3/ha and ≤100 m^3/ha
Red-winged Crossbill:	total stand volume >100 m^3/ha and ≤175 m^3/ha
Pine Marten:	total stand volume ≥150 m^3/ha

In Strategy "A" you harvest the forest on a 60 year rotation. In Strategy "B" you harvest the forest on an 80 year rotation. In both cases you employ a 300 year planning horizon. Assume year 1 of the forecast is 2010.

After some period of time, the forest structure would stabilize and harvest volume and habitat areas would become constant year-to-year. **Enter in Table 3 the harvest levels (in m^3/yr) and habitat areas (in ha) as they would result once the forest structure stabilizes under each strategy.** *[14 marks]*

Enter in the last column of Table 3 the *calendar year* of the forecast period by which time the forest structure will stabilize and harvest and habitat levels will become constant. *[4 marks]*

Table 3.

Strategy	Harvest (m^3/year)		Species Habitat Area (ha)				Year after which values become constant
	Total Volume	Sawlog Volume	Common Yellowthroat	Parula Warbler	Red-winged Crossbill	Pine Marten	
A							
B							

[6] The allowable cut effect has been incorporated in the design of forest management strategies in some jurisdictions in North America.

Briefly, but clearly explain what the allowable cut effect is, and why it can increase the financial attractiveness of implementing silvicuture programs to increase wood supply. ***[10 marks]***

[7] The present age class distribution of a forest is shown in Figure 11. All stands in the forest follow the same patterns of development. These patterns are expressed for live biomass carbon content in Figure 12, and for timber volume in Figure 13. Using only the information provided here, answer the questions on the following page.

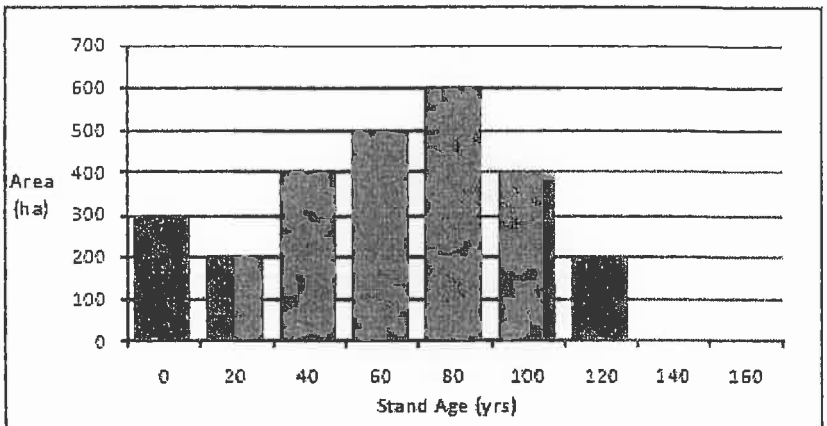

Fig 11. Forest age class structure in 2011.

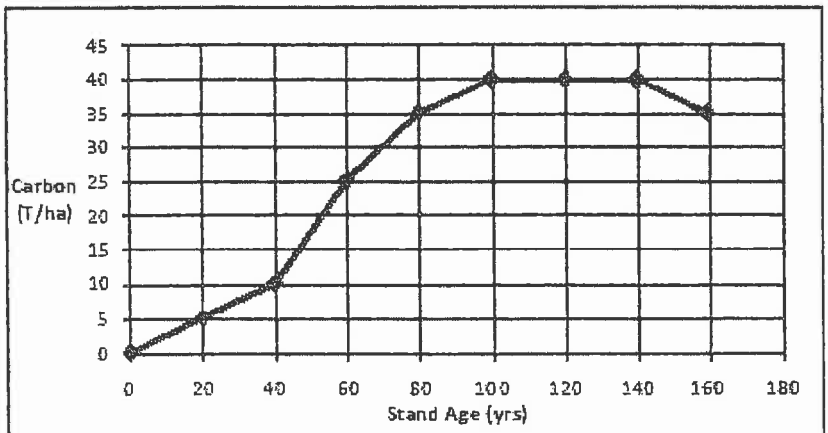

Fig 12. Carbon content in live biomass.

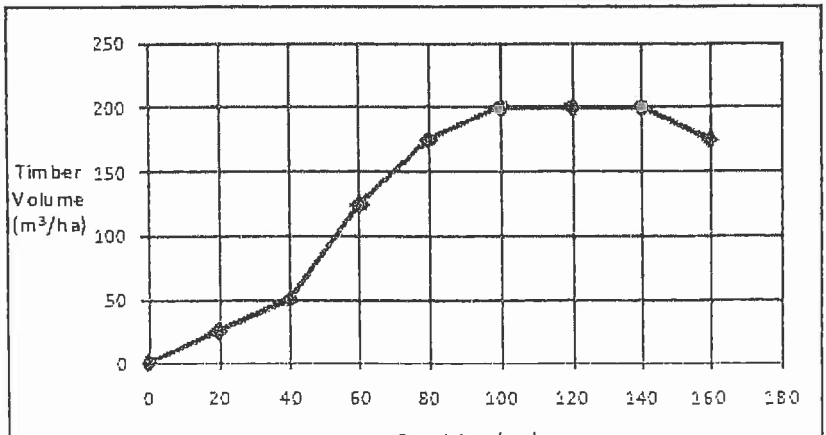

Fig 13. Timber yield.

How much total carbon is stored in the entire forest at present? Show calculations in the gridded table below.

[10 marks]

Carbon stored in the forest in 2011 =

Over the next 20 years, stands in the forest are harvested to generate 2000 m^3/yr (i.e. 40,000 m^3 over the entire 20 years). Oldest stands are ranked first for harvesting and harvested stands regenerate to age zero and follow the patterns shown in Figure 12 and 13.

What is the age structure of the forest in the year 2021? Enter the correct values in Table 4. ***[10 marks]***

Table 4.	
Stand Age Class (yrs)	Area of Age Class (ha)
0	
20	
40	
60	
80	
100	
120	
140	
160	
180	
200	

[8] The forecast outcomes of a proposed management strategy are illustrated in terms of four indicators in Figures 14-17. The proponent of the strategy claims it to be sustainable.

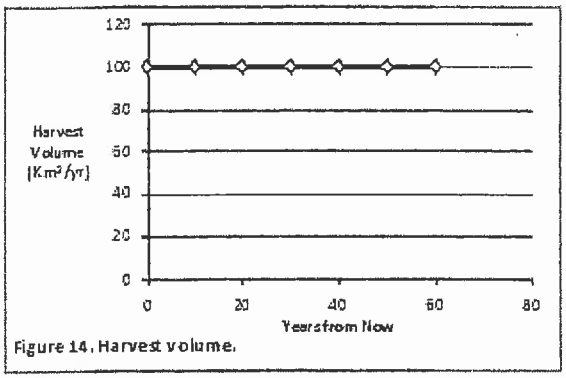

Figure 14. Harvest volume.

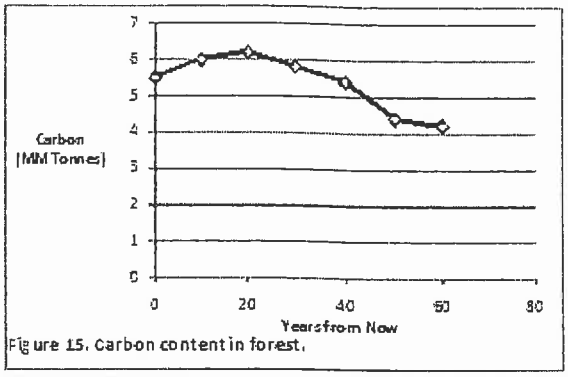

Figure 15. Carbon content in forest.

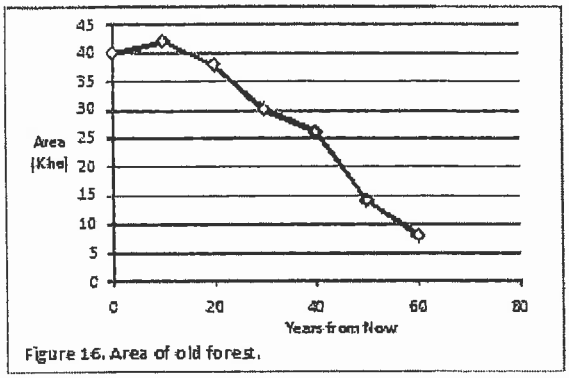

Figure 16. Area of old forest.

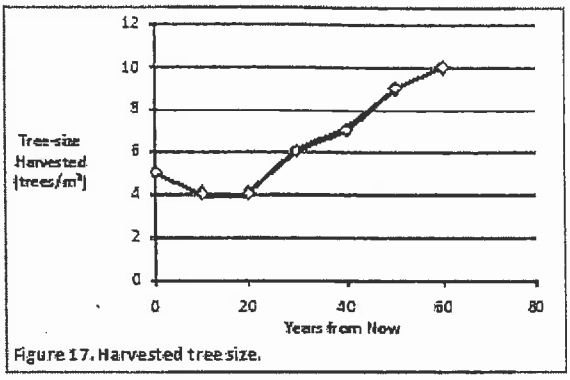

Figure 17. Harvested tree size.

Considering contemporary concepts of sustainability, on what grounds would you challenge the proponent's claim? ***[10 marks]***

What simple change to his analysis would you suggest to better reveal the sustainability of the strategy? ***[4 marks]***