ECO6143 Natural-Resource Economics
Mid-term exam March 17 2006
University of Ottawa
Closed book exam
Professor: Louis Hotte
Time allowed: 2h00m

1. Review question (50 points) A renewable resource with existence value (Adapted from Clark, 1976, p. 65)

A community lives next to a renewable resource that has a natural growth rate of $F(x_t)$, where x_t denotes the stock of the resource at time t and $F''(x_t) < 0$. $F'(x_t)$ is initially positive and turns negative after passing the maximum sustainable yield, as is standard for renewable resources (logistic function). The total harvest rate at time t is denoted h_t. The unit harvest cost is $c(x_t)$, with $c'(x_t) < 0$, and the resource sells for a constant unit price p. In addition to its commercial value, the stock of the resource brings some "existence" benefits to the community, which we denote as $V(x_t)$, with $V'(x_t) > 0$. To simplify, we assume that V represents a flow of instantaneous *aggregate* benefits to the community.

(1) Solve for the optimal use of the resource as if it were managed as a sole owner by the community, i.e. it maximizes the present value of the sum of commercial and existence benefits as follows:

$$\max J = \int_0^\infty e^{-\delta t}\{(p - c(x_t))h_t + V(x_t)\}dt \tag{1}$$

Interpret the necessary conditions for a maximum that you obtain. What is the meaning of the shadow-price of x_t?

(2) Characterize the steady-state. Show how the presence of existence benefits affect the optimal steady-state stock level?

(3) Imagine that the resource is sacred such that any decrease in its stock has a dramatic effect on $V(x)$, i.e. $V'(x)$ is very large. What would be the likely steady-state optimal stock level in that case?

(4) Assume now that the resource is non-renewable, i.e. $F(x_t) = 0$. Could you conceive of a steady-state with a positive stock of the resource? Show why or why not.

2. Non-renewable resource exploitation (50 points) Show how a similar increase in the stock of a non-renewable resource can affect its price and extraction paths when it is <u>anticipated</u> and when it is <u>non-anticipated</u>. Use a four-quadrant graph. In the first case, assume that you are now at time 0 and that the change is anticipated to occur at a future specific date, say at date t_0. In the second case, you are now at date 0 and the change occurs at that same future time t_0, but it is a total surprise. Compare the two cases and interpret.