

Name: _____

SOS 325

Homework #5: Renewable Resources, Common Property and Open Access

Answer all questions on this sheet of paper and turn it in in-class on Thursday, December 6th. If you cannot turn your assignment in in-class then you can place it in my mailbox (4th floor Wrigley Hall – you can leave your work with Theresa the receptionist) or submit it electronically via Blackboard. Do NOT email it to me or the TA. Make your answers clear, legible and to the point.

1. (100 pts.) Consider a resource whose net growth in biomass (X) each year $F(X)$ is given by a logistic growth function where $r=.1$ and $K=1$. (You can think of the units of the biomass as being millions of animals so that the carrying capacity of the environment is one million animals.)

$$F(X) = rX(1 - X/K) = .1X(1 - X)$$

Suppose that harvest occurs according to the following relationship: Yield = $Y=qEX$, where E is “effort” pursuing the resource (number of boats for a fishery or number of hunters for big game hunting) and $q = .0025$.

- a. (10 pts.) Graph the growth function of the biomass $F(X)$, being clear to label maximum sustainable yield (MSY) harvest, biomass levels at MSY and carrying capacity on your graph. What is the maximum amount of harvest that can be sustainably achieved in this system? What level of biomass generates this amount of harvest?

- b. (15 pts.) Now, using the equation derived in class and in Keohane and Olmstead, graph the curve showing the sustainable harvest for any given amount of effort (the “harvest/effort” or “yield/effort” curve). What level of effort exhausts the resource? What amount of effort is consistent with the maximum sustainable harvest of the resource?
- c. (15 pts.) Suppose ecologists discover that $r=.05$ rather than $.1$ so that the growth rate for any level of biomass is now much lower than thought. Graph the new yield/effort curve. How does this change your answers to the previous question? If managers set effort to the level that would maximize sustainable yields in question b), what would happen to the biomass over time?

d. (20 pts.) Sticking to the parameter values given in a) and b), suppose that the price of a single unit of harvest is 1000 (so that the sustainable revenue/effort curve is 1000 times the harvest/effort curve you've already found in question b) and the cost of a unit of effort is constant and =1. Find the level of effort that maximizes sustainable profits. (NOTE: It is ok to find this number graphically or by trial and error substitution into the equation.)

e. (20 pts.) Find the level of effort that you would expect to occur under open access conditions. How does this compare to the level found in question d)? Can you tell if the stock will be biologically overexploited (i.e. at a level of biomass below the level consistent with the production of maximum sustainable yield)?

- f. (10 pts.) Suppose that the resource stock is privatized to a single individual or corporation. How much effort would you expect them to utilize assuming that they have as their goal the maximization of sustainable profits? Would they have an incentive to defend the resource against encroachment by other users? Why?
- g. (10 pts.) Resource managers, faced with the open access conditions described in e), subsidize fuel costs and supply low-interest loans to harvesters, lowering the marginal cost of a unit of effort. The objective of this program is to improve the livelihoods of resource-dependent communities. Graphically demonstrate how this affects the amount of long-run effort in the industry. What happens to sustainable profits? Resource stocks?