ECN 275/375 Environmental and natural resource economics
Exercise set 15 – fisheries

Exercise 15.1 – Properties of the stock-net growth relationship

In fisheries economics and management, the relationship between stock size, S, of a fish species and the net growth (birth minus natural deaths), $g(S)$ in biomass is important to understand the impacts of fishing (harvesting) on the fish species.

(a) Draw a typical *stock size - growth in stocks* graph, and label the axes. Identify the maximum sustainable yield stock, S_{MSY}, and net growth $g_{MSY}=g(S_{MSY})$, and the maximum stock size, S_{MAX}.

(b) Introduce a sustainable harvest level, H'. In the same graph as in (a), mark the stock size-harvest equilibria, and discuss their stability. What could theoretically happen to the fish stock if the the harvest level is maintained at H' and the stock size is less than S_U.

(c) What would entail a virgin fishery, i.e., a fishery on a fish stock that never had been subject to fishing before?

(d) Indicate the maximum sustainable harvest level, H_{MSY}, and discuss the stability properties of the ensuing equilibrium. Given your stability analysis, discuss the desirability using maximum sustainable harvest as an objective for managing a fishery.

Exercise 15.2 – Mathematical and graphical analysis of a steady state fishery

Fisheries are usually framed in an effort-harvest dimension, where harvests, H_t are framed as a function of effort, E_t. Assume a steady state equilibrum, i.e., fish stock sizes S_t and the net growth as a function of stocks, $g_t=g(S_t)$ are unchanged over time.

(a) Write a mathematical model for maximizing the rents (profits) from a steady state fishery. Be clear on what is the decision variables.

(b) State the necessary first and second order conditions finding the profit (rent) maximizing solution. Interpret the conditions.

(c) Draw a graph of the equation in (a) that is consistent with the conditions in (b). Mark regions where the necessary conditions hold (hint: they need only to hold locally around $E_{\Pi max}$).

Remarks:

1. It is analytically easier to use the formulation of first order condition with relative prices, i.e., $H_E=\frac{w}{P}$. One reason for this is that an increased price P would lower the blue price line and increase the profit maximizing effort (and higher costs for effort would shift the relative price line up → the optimal effort decreases).
2. The marginal product becomes negative for effort levels beyond $E_{\Pi max}$.

(d) How would you find the open access effort, E_∞. Explain your reasoning.

Previous exercise 15.3 has been moved to exercise set 16 where it belongs thematically due to a rearrangement of the lectures.