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PPA 990 Natural Resource Economics

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Exercise 5

Suppose that in the absence of human intervention the stock of tuna, b, would change according to the following equation: $db/dt = 10b - 0.01b^2$. Furthermore, suppose e units of fishing effort will produce a harvest of tuna x given by $x = 0.01be$. Finally, suppose the cost of e units of effort is \$2e, where \$2 is the wage rate, and that the price of tuna is constant at \$1 dollar per unit of x.

(a) Find the profit-maximizing sustainable equilibrium for this model when the tuna are *not* common property (that is, when the level of effort can be controlled). Solve for the levels of b, e, x and profit.

Now suppose the government allows free entry into the tuna fishing industry but imposes two ad valorem taxes: τ^w on wages and τ^p on profit. The cost of e units of effort now becomes \$2$(1+\tau^w)e$ and after-tax profit becomes $(1-\tau^p)\pi$, where π is profit before the profit tax. Finally, assume people in the industry behave in such a way that the level of fishing effort can be described by the following differential equation: $de/dt = 1.04(1-\tau^p)\pi$.

(b) Calculate the long run equilibrium levels of b, e, x and π when both tax rates are set to zero. Evaluate this outcome relative to the one from part (a). Is it better or worse? Why?

(c) Suppose the government wants to use τ^w and τ^p to improve the outcome in the tuna industry. Find a tax policy (that is, settings for the two taxes) that would move the long run market outcome to the efficient steady state from part (a). Discuss your results.

(d) Now find a tax policy that would accomplish the goal in part (c) *and* would insure that for points near the steady state the industry would move toward the steady state without oscillations. Explain your results.

(e) Draw a phase diagram for the model from part (d). Put the level of effort on the horizontal axis (just for the sake of practice -- this is different from what we did in class). Show the steady state, the isoclines and the directions of motion. Also, show paths from starting points in two different quadrants to the steady state. Sketch the integral curves for these paths.