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REM 621

<https://github.com/christiancarson/REM621>

1. Imagine a friend has been given a 100-year license to harvest a stand of 12,000 trees and they have asked you to give advice on how to maximize net present value over that time span assuming two options on discount rate (3% and 8%). The current lumber price for each tree is $100, and you look through the literature and find that this tree has an intrinsic growth rate of 0.21.
   1. Approximately, how long is best to wait between each harvest? When harvest occurs, approximately how much should they harvest? (I.e., all of the trees? Half? A quarter?)
      1. The intrinsic growth rate of this population is relatively high but due to the logistic nature of growth, the growth slows down as the population approaches K. This means that the optimal method to achieve maximum NPV across 0%, 3%, and 8% discount rates is one that capitalizes on the highest growth rate of the trees. In this case, I was able to find the most optimal combination after experimenting with increasing the standardized rotation period steps (5 years) from 5 to 100 years and increasing harvest rates at 5% steps from 5% to 100%. For the 3% discount rate, harvest every 5 years with 50% harvest rate maximizes NPV (Harvest Regime 1 = $2,471,962.76). Conversely, for the 8% discount rate, harvest every 10 years with 80% harvest rate maximizes NPV (Harvest Regime 6 = $1,338,812.44).
   2. If you were able to use additional forestry practices (say, thinning out new trees) to increase r to 0.4, how would that impact the timing of the rotations?
      1. Increasing the growth rate would shorten the optimal rotation period, as more frequent harvesting would yield a better NPV because trees grow faster. In terms of discount rate, the incentive to harvest more quickly for immediate revenue gains would probably outweigh the discounting of future revenues. Playing around with the same standardized augmentation of harvest rate (5% increases) and harvest rotation (5 year increases), I found that the optimal combination for a 3% discount would be a harvest every 5 years (the same as before) but with 65% harvest rate to maximize NPV (Harvest Regime 7 = $3,951,730.76). As proposed above, in the case of the 8% discount rate, the harvest rate decreases, but the harvest rotation shortens. The most optimal setup for the 8% discount rate would be harvest every 5 years with a 75% harvest rate to maximize NPV (Harvest Regime 8 = $ $1,910,088.16).
2. Fishers in an area have been complaining that they just can't make ends meet anymore because catch is declining, and they ask for help in the form of a subsidy to offset 50% of their costs.
   1. Using the parameters we adopted in class, what will happen to total catch for the fishery?
      1. Total catch is yield, which is determined by = catchability \* effort \* biomass. As effort increases, the yield also increases, but then starts to decline in response to biomass decreasing due to overfishing. With a 50% subsidy, the effort would increase because the cost to fish has gone down. With this increased effort, the yield would also increase at first. But at some point if the fishery is overfishing this could lead to a decline in biomass, in turn negatively impacting the yield as there are less fish available.
   2. What is the maximum sustainable yield for this fishery, and at what level of effort can we achieve it?
      1. MSY is the absolute largest yield that can be taken from a population or stock over some biologically relevant time period (typically based on the fishes reproductive rete). In this case, MSY assumes intrinsic growth rate and carrying capacity are constant. So, MSY, is carrying capacity divided by 2. That said, it always be 50, despite economic circumstances as it is biologically and environmentally controlled. In any case, the level of effort at carrying capacity is 20, producing a yield of 5.
   3. What is the maximum economic yield for the fishery, and at what level of effort can we achieve that?
      1. MEY is the level of effort (or catch) that creates the largest difference between total revenue and total cost, resulting in the highest profit. The MEY yield (Y\_MEY\_Subsidized) of the subsidized fishery is 4.982 at an effort level of 18.8 (E\_MEY\_Subsidized), whereas the unsubsidized fishery is at 4.928 (Y\_MEY) with an effort at 17.6 (E\_MEY).
   4. What combination of parameters would you need to have MSY happen at a lower effort level than MEY?
      1. MEY is controlled by four parameters; intrinsic growth rate, catchability, price, and carrying capacity. Augmenting the intrinsic growth rate catchability in combination or on their own could lead to reaching MSY at a lower effort level, but it they are limited all by carrying capacity in becoming lower than E\_MEY. The only way to have MSY happen at a lower effort level than MEY in this scenario (where carrying capacity can’t change) is to lower cost substantially, in this case through a larger subsidy. This would essentially mean that the fishery would have to have negative costs, so that they are able to fish a lesser amount (lower effort) than what is at MSY. As such, this is not a very realistic scenario.