

Surplus Production Model for Anchovy

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Introduction

Today we are going to tackle the mechanics of producing a surplus production model for anchovy using some reasonably realistic data (the data was estimated from actual data plotted on a graph). This should give you some actual experience dealing with the cold reality of fisheries data.

The Peruvian anchovy Fishery

Recall that we mentioned in lecture that the Peruvian anchovy fishery crashed abruptly in the 1970's. Here are the catch data from the preceding decade.

<u>Year</u>	<u>*Total Effort</u> (f)	<u>CPUE</u> (million tonnes)
1960	10.5	0.50
1961	14	0.60
1962	20	0.47
1963	25	0.40
1964	25	0.41
1965	24	0.37
1966	20	0.42
1967	24	0.42
1968	24	0.43
1969	24	0.44
1970	20	0.53
1971	19	0.55

* effort is measured here in Gross Registered tonnage (GRT) of fishing vessels

The Goal

Keep in mind the goal. The goal is draw a surplus production model, i.e., a graph with a dome in it plotting total catch versus biomass. In this exercise, and in classical fisheries, we utilize the "equilibrium" method, which means that we assume (though it is hard to believe) that the population is in equilibrium each year and this allows us to assume that we can use effort as a surrogate for biomass. So, our goal is to plot a graph of Total catch versus total effort.

Step 1. Estimating the slope and intercept of the CPUE versus effort graph

Recall that the catch versus effort (f) curve can be plotted as

$$\text{Catch} = (m f^2) + (b f)$$

where m and b were taken from the regression of CPUE on f.

So, plot a graph of CPUE versus f, do a regression of CPUE on f, and obtain values for m and b. Extend the regression line to go from an Effort of 0 to an Effort of 60

Step 2. Plotting the Surplus Production Model

On a separate graph, plot the surplus production model (catch versus effort) plus the actual catch data. To do the later, you need to compute a column of actual catch values: this will be the product (multiplication) of CPUE * f for each year. These are data and should be represented by points.

To do the former, you need to plot the relationship

$$\text{Catch-curve} = (m f^2) + (b f)$$

where you obtained the values of m and b from Step 1. f is the x-axis variable. This is a relationship and so should be plotted as a continuous curve, not data points.

When you try to do this you will discover that the range of actual effort values is very small and doesn't encompass the whole curve. You will need to extend the curve beyond the range of actual values. I strongly suggest you plot this curve for every value of effort between 0 and 60, and you will get a nice even curve from which you can read the MSY (the highest point).

Turn on minor x and y axis gridlines to locate the MSY.

Recall that an important part of the biology of this species is that seabirds consume a huge number of anchovy (roughly 18%). So, if the MSY is around 11 million tons we need to leave 2 million tonnes for the birds. As you can see, we didn't, with human catches often exceeding 10 million tonnes, making a total catch of over 12 million, way beyond the MSY.

To hand in:

Hand in printouts of your spreadsheet and the two graphs.

On the surplus production model, indicate with an arrow where the MSY (Maximum Sustainable Yield) is achieved and write on your graph the MSY and the F_{MSY} (the effort required to achieve the MSY)