

FISH 6004. Assignment 2

Due October 21, 2021

Marks: 25% of course total

Please copy R scripts and outputs into a word file and submit to me. Organize and label your results clearly. Use captions for any tables or figures you create. You will be marked for clarity of presentation as well as correct results. Email your completed assignment to me, noel.cadigan@mi.mun.ca

1. 3Pscod_survey.dat contains annual survey catches of cod in NAFO Subdivision 3Ps for 1997-2010.
 - a. Estimate the population average survey catch (in numbers) each year, and provide a table of results (*4 marks*).
 - b. Provide estimates of the variance of these estimates, and include in the table (*4 marks*).
 - c. Plot the time series of annual average catch along with 95% approximate confidence intervals (*5 marks*).
 - d. Comment on problems with survey coverage over time (*2 marks*).

Please show all workings.

2. Show for the Schaefer surplus production model that
 - a. The exploitation rate (H) that maximizes long-term equilibrium catch is $H_{msy} = r/2$. **Hint: first find the long-term equilibrium catch.** (*10 marks*)
 - b. What are the equations for the equilibrium population size and catch when $H=H_{msy}$. (*5 marks*)
3. The file bio_data.txt gives some recent basic growth and mortality information for American plaice in NAFO Subdivision 3Ps, including estimates of the fishery selectivity (sel) for different ages.
 - a. Plot the YPR curve. Find the values for F_{max} and $F_{0.1}$ and show them on the YPR plot (*5 marks*)
 - b. If m is actually 0.1 for fish older than age 7, plot the YPR curve and describe how the change in m affects the YPR curve compared to a)? Compare the change in the values of F_{max} and $F_{0.1}$. (*5 marks*)
 - c. Plot the %SPR curve for American plaice (with $m=0.2$ for all ages). What is F_{35} and F_{20} ? Show these values on the plot. (*5 marks*)

4. Assume in Example 3 that a Beverton-Holt stock-recruit curve is appropriate, with $\alpha = 1$ and $\beta = 0.5$. Plot the equilibrium yield curve and clearly identify F_{MSY} in the graph. Also show the values of F_{max} , $F_{0.1}$, F_{20} , and F_{35} . (10 marks)

5. In the continuous population dynamics context, consider a fishery that fully selects all mature fish so that $mat(t) = s(t)$ for all t . Show that $\partial YPR(f)/\partial f|_{f=0} = SPR(0)$. In this case what is the relationship between the slope of the YPR curve at $f = F_{0.1}$ and SPR? (10 marks)

6. In the continuous population dynamics context:

- a. for the Beverton-Holt stock-recruit function, show that

$$\frac{\partial Y_e(f)}{\partial f} = \frac{\beta}{SPR(f)^2} \frac{\partial SPR(f)}{\partial f} YPR(f) + R_e(f) \frac{\partial YPR(f)}{\partial f}$$

Use this result to show that $F_{max} \geq F_{msy}$ in this case. What is the implication of harvesting at F_{max} in the long run. Hint: think about the sign of the derivatives of the YPR curve when $F < F_{max}$ and $F > F_{max}$ and the sign of the derivatives of the equilibrium yield curve when $F < F_{msy}$ and $F > F_{msy}$ (10 marks).

- b. If recruitment does not depend on SSB, show that $F_{max} = F_{msy}$ (5 marks).

7. Poisson random variable Y with mean μ ,

- a. Derive the expected value of Y (5 marks).
 b. Derive the variance of Y (5 marks).
 c. For a random sample y_1, \dots, y_n of size n from a Poisson distribution, derive the show that the maximum likelihood estimate of μ is $\hat{\mu} = \bar{y}$, the sample average. (5 marks)
 d. Generate a random sample of size 30 in R with a Poisson mean of 10. Estimate $\hat{\mu}$ and $Var(\hat{\mu})$ with this data. Provide a histogram of the data and indicate $\hat{\mu}$ on the graph. (5 marks)