**FISH 458/558 - Fish Population Dynamics**

**LAB 14 ASSIGNMENT (Surplus Production models)**

*Complete and return your assignment (via Canvas) in the form of a Word document (with any answers and figures requested and with the R script copied in). Turn it in by the posted due date.*

*Guidelines:*

* *Include course, lab number, and date at the top of the document*
* *Number and label the questions and answers clearly! (We should easily be able to find your answers!)*
* *Include all of the requested output (e.g., values, data tables, and plots), not just the code for them. (We will not copy your code into R to see if it works).*
* *Include informative captions for figures and tables. See research articles for examples. [We will take points off this time if these are not included!].*
* *Submit a Word document unless directed otherwise (no r files or pdfs please).*
* *Include all your code used for the problems.*
* *Answer ALL questions using complete sentences that are clear and informative.*

**458 AND 558 Students (23 pts):**

The assignment is to fit a discrete, surplus production (Schaefer) model to data for the North Australia tiger prawn fishery, and interpret the parameter estimates and stock trajectory from a management perspective. The data are in the “**TigerPrawnData.csv**” file (taken from the “Barwick 2011 (Report) - Northern Prawn Fishery data summary.pdf”). Catch is measured in tons, and effort is measured in vessel days. For the analysis, use the observation error method *only* to fit the data, and assume a multiplicative and lognormal error structure. For this HW, you should be able to import the new dataset and run the lab script without making any modifications, except changing the name of the dataset and maybe some figure labels. I encourage you to work and discuss with others.

1. Fit the surplus production model to the data and report the estimated parameters (K, q, r, sigma). [See notes at the end of this file.] Define and describe what each parameter is. (4 pts)
2. Generate a plot that demonstrates the fit of the model to the observed CPUE data, and describe how well it fits (or not). (2 pts)
3. Calculate and report the values of the pertinent management quantities (MSY, Emsy, Bmsy, umsy). Describe what each of these management quantities represent. (4 pts)
4. Generate the following plots with appropriate figure captions (6 pts):
   1. Biomass through time (with a reference line at Bmsy)
   2. Effort through time (with a reference line at Emsy)
   3. Catch through time (with a reference line at MSY)
   4. Exploitation rate (u) through time (with a reference line at umsy). (Note: ut=Ct/Bt)
   5. Catch (on the Y-axis) vs. Biomass (on the X-axis) (with a curve for surplus production)
   6. Catch (on the Y-axis) vs. Effort (on the X-axis) (with a curve for surplus production )
5. Describe what is being shown in the 2 plots you generated for question 4e and 4f, and what the significance of the plot is. (2 pts)
6. Assuming the data and results are reliable, summarize the status of the North Australian tiger prawn fishery based on your mini-stock assessment. Make sure you refer to all the plots you created. Lastly, state what management advice you might give for this fishery. (4 pts)
7. Answer these questions (1 pt):
   1. How many hours did you spend on this assignment as a whole?
   2. I continue to encourage you to work with classmates collaboratively. Did you work with anyone else or at least consult with someone? Who? How did you communicate?
   3. Were there any particular things you struggled with in this lab and how did you overcome them?

**558 Students:**

Work on your projects, and provide a short summary of the progress you made.

**Notes on fitting models:**

* **For this HW, you should be able to import the new dataset and run the lab script without making any modifications, except changing the name of the dataset and maybe some figure labels. However, below is some general advice if you were doing this for some other dataset.**
* Fitting models can be tricky, and the nonlinear optimization may not work. Possible solutions to this problem are listed below:
  + Trying different starting values for the parameters. For this HW, this has proven to be sufficient for students. To figure out what some reasonable starting values are, you can try:
    - 1) you can make educated guesses and use trial and error.
    - 2) You can manually generate predictions from a given set of starting parameters and modify them until the prediction approximates the observed data. For this, you can set up a worksheet in excel or you can do this in R (see lab script for example).
  + Reducing the number of parameter you are estimating by fixing B0 and/or q). For example:
    - You can also assume that the initial biomass (B0) is equal to K, but this is already something that we did in the lab.
    - There is a closed-form (ie analytical) solution for q, which means it can be manually calculated given the other parameters and the observed data (Haddon 2011, p. 300). The catchability, q, can be calculated as:
      * 
      * Where is the estimate for q, n is the number of years in the data set, It is the observed index (or CPUE) value in year t, and is the Biomass predicted from the Schaefer model for year t which is calculated from:
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