Exercises “A NEW R-PACKAGE FOR THE ANALYSIS OF THE FISHERIES POPULATION UNDER UNCERTAINTY”

Note that:

- Exercises 1-3 can be solved using tutorial 1.
- Exercises 4-8 can be solved using tutorial 2.
- Exercise 9 can be solved using tutorial 3.

1 Exercise 1

Use the operating model implemented in Rfishpop to simulate a population with the following parameters which try to mimic the behaviour of a long life specie as hake.

- Years: from 1980 to 2020.
- Ages: 0 to 20.
- Deterministic population.
- Minimum and maximum age (respectively) for which the corresponding fishing mortality is considered to compute the mean fishing mortality: 4 and 10.
- Time of the year at which the catches are simulated: midyear.
- Number corresponding to the population size at first age and year: 100.000.
- Rates of instantaneous natural mortality for each year and age: constant 0.2.
- Parameters of “Von Bertalanffy Growth Model”: $L_\infty = 100, t_0 = 0, k = 0.15$.
- Parameters of the Length-Weight relationship: $a = 10^{(-5)}, b = 3$.
- Parameters of the logistic function used to generate the maturity matrix: $a50_{Mat} = 3, ad_{Mat} = -0.5$.
- Logistic selectivity function with parameters: $a50_{Sel} = 3, ad_{Sel} = -1$.
- Argument f annual component of fishing mortality $F = f \times SEL$ constant equal to 0.5, for all years.
- Stock recruitment model: Beverton-Holt Recruitment Model with $a_{BH} = 100000; b_{BH} = 10000$.

2 Exercise 2

Access to the following information of the population created above and provide some comments about such results.

- Population size for each age and year.
- Instantaneous fishing mortality for each age and year.

- Proportion of mature at each age and year.
- Number of catches for each age and year.
- Weight of catches for each age and year.
- Weight of the catches for each year.
- Total biomass for each year.
- Maturity biomass for each year (spawning stock).

3 Exercise 3

Compute and interpret the "Steepness" of the stock recruitment model considered in **Exercise 1**. Assuming: Fish.years=3, Bio.years=3, Method="mean". Which is the meaning of such parameters?

4 Exercise 4

Review the concepts "Biomass-per-Recruit" (BPR) and "Yield-per-Recruit" (YPR) (tutorial 2). Plot each curve using Bio.years=3, Fish.years=3, Method="mean". Choose f.grid such that you can see in the plot that for certain values of the fishing mortality the corresponding BPR is almost zero.

5 Exercise 5

Compute using $BYR.eq$ function the recruitment and the biomass in equilibrium for a virgin population, to wit before fishing. Obtain also the population size in equilibrium for each age.
Use Bio.years=3,Fish.years=3,Method="mean".
Carry out the same exercise but instead of a virgin population considering a population with fishing effort equal to 0.5 (as in your population, Exercise 1, argument f.grid).

6 Exercise 6

Check that the population size in equilibrium for each age derived from Exercise 5 **second part which consider the same fishing effort as your population** can be also obtained letting your population obtain equilibrium by itself, to wit, as the years go by, your population reaches equilibrium, perhaps in 2020 it has already reached that equilibrium.

7 Exercise 7

Compute the reference fishery mortality at which the MSY is attained and the corresponding effort of fishing, YPR, BYR, biomass, yield and recruitment in equilibrium.
Use Bio.years=3,Fish.years=3,Method="mean".

8 Exercise 8

Simulate again the population of Exercise 1, but introduce the following changes:

- Use the population size in equilibrium for each age derived from Exercise 5, instead of the N_0 established before, to start the population at its virgin state.
- Define argument f in such a way that in the first 25 years the population is exploited at 2 times the f_{msy} level and the remaining ones at the f_{msy} level.

9 Exercise 9

Compute several indices of biomass using $CV = 0.10, 0.20$. Plot the real biomass and the indices in the same graph.
Do the same exercise but now for obtaining a catch sample.
NOTE: Use $q_A < -SEL; gamma < -1$ for the biomass indices (furthermore the indices must correspond to January, that is, beginning of the year; tsampling=0).