

Monte carlo simulation model

Monte carlo simulation model

- Computer based technique length frequency samples are used for the model.
- In addition randomly varying elements of biological system are also simulated.

This model involves 5 steps.

- Before using this simulation model, the length frequency of fish sample need to be collected.
- The number of fish in each length need to be simulated. This should be taken random only.
- This model is called as “Monte carlo” because of the drawing numbers at random from a population done with roulette.

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- Thus a tool is generated to simulate random sampling. Because of this it is called “Random Number Generator” (RND).

Usually in RND the mean value is taken as 0.5 and the variance is $1/12$. The $RND_1, RND_2, RND_3, \dots, RND_n$ are designated as n calls of RND. Each RND gives a random number. The seem of RND_n expressed as

$$X = \frac{1}{\sqrt{n/12}} \sum_{i=1}^n RND_i - 0.5$$

and this will have the mean value 0 and variance 1, for value of n .

For accuracy of result, ‘ x ’ should be approximately distributed and ‘ n ’ should be larger. If many random numbers are produced in the program, the mean value and variance of these numbers will move closer to “0” and “1” respectively.

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Step 1 :

$$p_t = [1/t_{\max} \text{ if } t=0,12 \dots\dots t_{\max}]$$

o if otherwise.

t_{\max} is the maximum age of a fish can reach. This is taken as input.

- The age t is drawn from probability distribution and it pertains to the birth rate.
- The birth rate is taken as year and month. The probability will be generalized as

$$p_t = C_{y_i} / \sum C_{y_i}$$

Where C_{y_i} is the year class strength for class i .

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- In the probability distribution it is assumed that recruitment remains constant from year to year.
- If variations occurs in recruitment, this should be done by drawing ages (t) from a set of pre specified distributions, one for each year of recruitment.

Step 2

- If the fish species spawns all the year round, naturally recruitment occurs throughout the year. Here the number of recruits entering stock is taken as fist day of each month, the drawing of the month of birth is similar to drawing of age.

$$P_t = 1/12 \text{ (for 12 months / year)}$$

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Step 2

Here the seasonality of recruitment, when more pronounced, the relative recruitment strength (R_1) has to be considered.

The probability distribution can be expressed as

$$P_t = R'_i / \sum R'_i$$

R' is the relative monthly recruitment strength.

Monthly recruitment = $(1/12)$.

$$(R'_i / \sum R'_i) N_{\max}$$

N_{\max} the maximum number of recruits in a particular month of a period. The monthly recruitment is considered as absolute number of recruits.

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Step 3

In step 3, the growth parameters such as L_{∞} , K , C and W_p should be calculated with prespecified mean values as standard deviation as inputs.

Step 4

From the age of the fish, the probability survival is calculated and cumulative total mortality should be calculated for all months.

The cumulative total mortality can be calculated as

$$Z = \sum F_{\max} P_{L_i} + M_i$$

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Step 4

$$Z = \sum F_{\max} P_{Li} + M_i$$

F_{\max} = maximum fishing mortality of fish exposed during its life.

M = Natural mortality

P = product of left hand selection and right hand selection.

Usually left hand selection accounts in gear selection of small fish, which escapes through the meshes of a trawl, while right hand selection is the gear selection of larger fish, not caught in gill net or migration out of the fishing grounds.

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Step 4:

$$P_L = [1/1 + e^{(S_1+S_2-L_1)}] \cdot 1 - [1/1 + e^{(S_1+S_2-L_1)}]$$

When

$$S_1 = \ln(3) \cdot L_{50} / (L_{75} - L_{50})$$

$$S_2 = -S_1 / L_{50}$$

$$S_3 = \ln(3) \cdot R_{50} / (R_{75} - R_{50})$$

$$S_4 = -S_3 / R_{50}$$

When L_{50} and L_{75} are the length in which 50 and 75 percent of the fish are available for left hand selection and R_{50} R_{75} are the lengths are which 50 and 75 percent respectively of the fish are not available due to right hand selection.

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Step 4:

$$P_t = e^{-Z}$$

P_t = probability of survival.

By this distribution it could be decided to include or exclude a fish in the sample

Step 5:

$$P_t = P_L$$

To include or exclude a fish from the sample is determined from probability distribution.

P_L is the fraction of the stock of length L that is available to the fishery.

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- P_L infers that some fish are not available to the fishery because they have not been recruited to the fishing grounds and while other fish are not caught because of gear selection.
- Usually P_L is the value of a resultant curve which is product of the curve expressing the recruitment to the fishing ground and the gear selection proper

Step 6

- With the desired number of samples simulation has to be determined on desired samples are to be added up if the desired samples not enough, the process should be repeated from step 1 onwards.
- The length frequency data need to save in a file on printed as output of the simulation process.

END